GEOLOGICAL SURVEY OF ALABAMA
WALTER BRYAN JONES, DIRECTOR

SPECIAL REPORT 19

IRON ORE OUTCROPS OF THE RED MOUNTAIN FORMATION

IN NORTHEAST ALABAMA

BY
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Department of the Interior

Prepared in cooperation with
the United States Geological Survey

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LETTER OF TRANSMITTAL

UNIVERSITY, ALABAMA

August 24, 1946

HONORABLE CHAUNCEY SPARKS,
Governor of Alabama,
Montgomery, Alabama.

Sir:

I have the honor to transmit herewith the manuscript of a report on The Iron Ore Outcrops of The Red Mountain Formation in Northeast Alabama, with the request that it be printed as Special Report 19 of the Geological Survey of Alabama.

Respectfully,

WALTER B. JONES,

State Geologist.

FOREWORD

When Dr. E. F. Burchard began his work on Alabama iron ores in 1904, it was generally thought that known reserves in the Birmingham-Bessemer area would be sufficient for several generations. Now, as this report comes into being, we find a shortage of satisfactory reserves and therefore a definite interest in any iron ores anywhere. Thus we feel that this report is timely and hope that it will serve both landowners and the iron and steel industry.

It should be recorded that Dr. Burchard has become a well known authority on iron ores of the world. In the summer of 1945, he retired from the U. S. Geological Survey. He then joined the Geological Survey of Alabama, to complete his manuscript for the present report and a similar one on brown iron ores of Alabama. It is hoped that the latter report can be printed in 1948.

In recognition of Dr. Burchard's outstanding work, the University of Alabama conferred upon him, in 1935, the honorary degree of Doctor of Science.

Dr. T. G. Andrews, Professor of Geology, University of Alabama, joined Dr. Burchard in 1937, and rendered valuable assistance, particularly in the Greasy Cove area.

While our iron ore deposits have been described in various reports of our Survey for almost a century, it was not until 1896 that the subject was covered in a separate report. In that year, Dr. W. B. Phillips' monograph "Iron Making in Alabama" appeared. It was revised in 1898, and again in 1912. In 1910, the U. S. Geological Survey published its Bulletin 400, entitled "Iron Ores, Fuels and Fluxes of the Birmingham District, Alabama." That was the first detailed work on any part of the subject. Dr. Burchard was senior author of that report. However, the present report is the second one in which a part of the subject is completely covered. It is with a measure of justifiable pride that we give it to our people.

WALTER B. JONES.

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TABLE OF CONTFNTS

Greasy Cove—(Continued) Page

Page

Page

LIST OF ILLUSTRATIONS

TEXT FIGURES

PLATES (folded and inserted)

ERRATA

Page

5, toward bottom, for Badhams read Badham.

15, toward bottom, for guage read gauge.

27, line 2, unsymmetrical is misspelled.

28. (Plate 2 is in pocket.)

31, line 13, for Garignes read Garigues.

74, line 1 (also on pp. 60, 95 and 273), phosphorus is misspelled.
(This is a common mistake of printers.)

93, near bottom, for randon read random.

105, last paragraph, *Streptelasma* should be capitalized.

191, line 1, for .2 miles read 0.2 mile.

272, last paragraph, for peices read pieces.

291, second paragraph, the page reference (314) is omitted.

303, near middle, for 3 read 5).

335, line 2, insert "the" before Tennessee.

(Some of these were overlooked by the proof-reader, and some by the printers after proof-reading. There are several other trifling misprints, which are hardly worth mentioning, or not easy to describe.)

The French word *Resume*, which should have an accent over the last letter, occurs in several section headings, but the printers did not have that kind of type, and therefore left off the accent.

Iron Ore Outcrops of the Red Mountain Formation In Northeast Alabama

By Ernest F. Burchard and Thomas G. Andrews
Geologists, United States Geological Survey
Department of the Interior

ABSTRACT

Northeast Alabama in the Cumberland Plateau region west of the Coosa River is underlain by Paleozoic sedimentary rocks ranging in age from Cambrian to Carboniferous (Pottsville). The plateau has been incised by several streams forming valleys which trend northeast-southwest following the axes of narrow anticlinal folds. Wills, Browns, Greasy Cove, and Murphrees Valleys are typical of these physiographic features. On the borders of these valleys are exposed the rocks of especial significance in this report—the Red Mountain formation—of Silurian age, which generally crop out in foothill ridges at the base of escarpments of the plateaus of Lookout, Sand, and Blount Mountains. The Red Mountain formation, formerly termed the "Clinton" and the "Rockwood" formation by the Federal and certain State Geological Surveys, is composed chiefly of sandstone and shale with beds of hematite, or red iron ore. The foothill ridges, such as Red Mountain in Wills Valley and Greasy Cove, have been formed by the resistant sandstones of this formation.

The iron-bearing zone is usually found near the middle of the Red Mountain formation, which in northeast Alabama ranges generally from about 500 feet to 700 feet in thickness. One to four beds of iron ore are present at various places. It is seldom that no iron ore is found except where part of the formation is faulted out of the section. The beds vary in thickness from seams a fraction of an inch thick to beds 7½ feet thick. This thickness is greater than that of any other iron ore bed in Alabama northeast of Birmingham. The thicker beds usually contain partings of shale of varying thickness. Where unaltered the iron ore bed contains iron oxide, calcium carbonate, silica, alumina, and small percentages of phosphorus and manganese. On the outcrop and generally for a few feet to a few hundred feet down the dip much of the calcium carbonate has been leached out by surface water, rendering the

ore slightly porous and with increased percentages of iron oxide and other slowly soluble ingredients. This is termed "soft" ore. Where only part of the calcium carbonate has been dissolved the ore is termed "semihard", and where little or none of the calcium carbonate has been removed the unaltered material is known as "hard" ore.

Analyses of typical bedded iron ore from northeast Alabama
(percentages)

	Fe	SiO_2	Al_2O_3	CaO	P	Mn
Soft ore	56.00	7.40	5.49	....	0.24	0.10
Semihard ore	37.87	7.56	4.14	12.52	.31	.05
Hard ore	29.58	3.95	3.80	22.62	.39	——

Originally deposited in horizontal lenticular beds, the ores have been tilted, folded, and faulted along with their associated rocks; generally they dip at moderate to steep angles, or, in places are vertical or overturned. Mining of the ores usually begins on the outcrop where the overburden is stripped as far down the dip as is feasible, then is continued through an underground slope driven down the dip with right and left openings on the strike of the rocks. Vertical beds are opened by shafts or slopes from which levels are driven on the strike. Mining has been at low ebb in this area for some years, although some soft ore from thin beds worked on the outcrop has been shipped to blast furnaces at Gadsden and Birmingham during World War II. Between 1900 and 1915 there were many small blast furnaces in Alabama, Georgia, and Tennessee that served as markets for these ores, whereas now only one remains active in northeast Alabama. Thicker beds of ore and large-scale mining operations at Birmingham have created conditions with which the iron ore beds of northeast Alabama can hardly compete.

This report records all the available data on the beds of red iron ore from the vicinity of Springville northeast to the Alabama-Georgia State line, including all that were painstakingly gathered by Prof. Henry McCalley, Assistant State Geologist of Alabama, and published in two reports in 1896 and 1897. The detailed descriptions follow a systematic (although monotonous) order, and are tied into a series of 14 maps by means of locality numbers. A large-scale detailed geologic map of Greasy Cove on a special topographic base has been introduced to illustrate characteristic

southern Appalachian geologic structure as well as to show the local distribution of the iron ore outcrops. The present report may be considered as supplementary to an earlier report[1] on the Birmingham district which adjoins the presently described area on the southwest.

Estimates of the reserves of iron ore that may be present under given conditions in individual areas are presented with comparisons of estimates published in 1909. Suggestions are made with regard to a vast reserve of potential bedded ore aggregating 312,000,000 long tons beneath the Lookout Mountain syncline which might be tapped by mining a few thousand feet farther down the dip from the nearest presently available reserves. The ore deposits described in this report appear to comprise a total of about 51,000,000 long tons of indicated and inferred recoverable soft, semi-hard, and hard ore. This quantity does not, of course, rank high as an ore reserve in comparison with those of large districts, but it is much greater than the quantity heretofore produced from this area. It would be very helpful locally if it could be converted into pig iron within the next generation.

Lookout Mountain together with its borders appears to be the only large iron ore-bearing area remaining to be thoroughly tested in Alabama. The vertical depth at which the bedded ore lies below the surface of the greater part of the Lookout Mountain syncline is estimated to range between 1,500 and 3,300 feet. Evidently much depends upon further drilling exploration, and it is advocated that it be undertaken, under either Government or private sponsorship. While such projects necessarily would be speculative their success would mean much for public and industrial welfare.

[1]Burchard, Ernest F., Butts, Charles, and Eckel, Edwin C., The Iron Ores, Fuels, and Fluxes of the Birmingham District, Alabama: U. S. Geological Survey Bull. 400, 204 pp., 1910.

INTRODUCTION

General Statement.—The results of a detailed study of the iron ore outcrops of the Red Mountain formation in northeast Alabama are presented herewith. This report is in reality supplemental to the report on the iron ores of the Birmingham, Alabama, district issued by the United States Geological Survey many years ago.[1]

Much of the data presented have been recorded at intervals during 40 years of studies by the senior author of the geology and economics of southern iron ores and. other mineral resources Some of the data have been published in short progress reports, as indicated in the Bibliography, and a great deal of information gathered by Henry McCalley, assistant State Geologist of Alabama, 1883 to 1904, on the beds of iron ore that crop out in the Tennessee Valley and Coosa Valley, has been incorporated into the present text, in geographic order, and located on the map plates, wherever possible, in order that the sections so painstakingly measured and recorded by him might be made available again for future prospectors. Data gathered by various observers over a long period of years possesses the advantage of having been obtained in many instances when mines were active and prospects were newly opened. Professor McCalley's observations were published in 1896 and 1897 and therefore date back at least 50 years.

A. M. Gibson noted the red ores in Murphree's Valley in his studies of that area published in 1893. C. W. Hayes mapped the general areal geology and structure of several 30-minute quadrangles in northeastern Alabama and adjacent states and described the iron ores in a very general way in the resulting geologic folios published in 1895 to 1902. As a result of a reconnaissance of a few mines and sections on the Wills Valley ores E. C. Eckel published a brief paper in 1906. In his work on the Paleozoic rocks of Alabama, which began in 1904, Charles Butts gave considerable attention to the character and distribution of the iron ore-bearing formation, having described it in certain geologic folios and in the latest report on the geology of Alabama. Data on deep drill holes in the plateau region have been derived from a report by D. R. Semmes on Oil and Gas in Alabama,[2] and from later reports by Edgar Bowles and L. D. Toulmin.

[1]Burchard, Ernest F., Butts, Charles, and Eckel, Edwin C., Iron Ores, Fuels, and Fluxes of the Birmingham District, Alabama: U. S. Geological Survey Bull. 400, 204 pp., 1910.

[2]Semmes, D. R., Oil and Gas in Alabama: Geol. Survey of Ala. Special Report 15, 400 pp. 1929.

Acknowledgments.—Beginning in October, 1928, work on the iron ores of northeast Alabama was carried on for about two years through the formal cooperation between the Geological Survey of Alabama and the United States Geological Survey . Grateful acknowledgments are due to Dr. Walter B. Jones, State Geologist of Alabama, and to Dr. Stewart J. Lloyd, Assistant State Geologist for their interest in generous support of the work, and to Dr. Robert S. Hodges, Chemist, Geològical Survey of Alabama, for analytical chemical work and assistance in the field. The late Mr. Joe R. Ryan, of Cohutta, Georgia, who superintended prospecting of ore beds at several places in Alabama for the Chattanooga Chamber of Commerce in 1911, made reports of certain ore sections given in following pages. Many corporations and individuals have furnished information. To mention all of these would be to list nearly all owners of land along the lines of ore outcrop, but all the local courtesy and assistance is gratefully appreciated and especial acknowledgment is made to the following concerns, some of which are no longer in existence: The Alabama Company; the Alabama Consolidated Coal and Iron Company; the Citico Furnace Company; the Gulf States Steel Company; the Jirama Ore Company; the Lacey-Buek Iron Company; the Sloss-Sheffield Steel and Iron Company; the Standard Steel Company; the Southern Iron and Steel Company; the Republic Iron and Steel Corporation; and the Tennessee Coal, Iron and Railroad Company.

For information furnished by the following individuals grateful acknowledgment is also made: The late Major E. C. Eckel of the Tennessee Valley Authority; tne late Charles Butts and E. O. Ulrich of the United States Geological Survey; Messrs. E. T. Schuler, Adolph Reich, James L. Herring, and E. W. Capen of Gadsden; R. A. Drake, George P. Walker, George P. Walker, Jr., Clarence Jones, and John Humphrey of Attalla; A. J. Blair, C. S. Blair, L. E. Geohegan, David Hancock, C. A. Moffett, and Erskine Ramsay and the late T. H. Aldrich, Henry Badhams, and W. J. Penhallegon of Birmingham.

Scope and plan of the work.—The detailed study of the iron ore beds has mostly devolved upon Ernest F. Burchard and Thomas G. Andrews. The work of the senior author in northeast Alabama was begun in 1906 and the field has been visited by him briefly at intervals of a year or more from 1911 to 1942. Papers resulting from the earlier work are listed in the Bibliography.[3]

[3]Titles of all papers mentioned here will be found in the list of references, pages 16-19.

Thomas G. Andrews, who began his field work in this area in 1937, has prepared the detailed geologic map of Greasy Cove, written much of the text describing the geology of that area, and has brought the data on prospecting and development of the iron ore beds of the whole area up to date.

The base maps available for studies of this area are general maps of the State of Alabama on scales of 1:1,000,000 and 1:5,000,000. On the latter scale a geologic map of the State has been issued to accompany Special Report 14 on the Geology of Alabama.[4] The United States Geological Survey has issued topographic maps of 30-minute quadrangles on a scale of 1:125,000 or practically 2 miles to 1 inch, with topographic contour intervals of 50 feet for some maps and 100 feet for others. The topographic maps covering northeast Alabama comprise the following quadrangular areas: Scottsboro, Stevenson, Gadsden, Fort Payne, Springville, and Anniston. The United States Geological Survey has issued descriptive geologic folios of the Stevenson and Gadsden quadrangles. There is also one special topographic map of Greasy Cove, southwest of Attalla, on a 1:24,000 scale with 20-foot contour intervals. The Tennessee Valley Authority has made (plane, not contoured) maps of the entire drainage basin of the Tennessee River on the scale of 1:24,000, each covering an area of 7½ minutes of longitude and latitude. These are termed planimetric maps and were surveyed by means of air photography. They are not of great significance to the present report because they do not comprise ore-bearing areas in northeast Alabama.

The plan of utilizing these various base maps in the present report is as follows: The State map, scale 1:1,000,000, serves as a base for showing in northern Alabama the areas of Red Mountain formation containing outcrops of iron ore differentiated as to thickness and commercial availability. On this map are plotted also the sites of drill holes that pass through the Red Mountain formation. This is Plate 1 of the series of maps.

[4]Adams, George I., Butts, Chas., Stephenson, L. W., and Cooke, C. W.: Geol. Surv. of Ala. Spec. Rept. 14, Geology of Ala., 312 pp. 1926.

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The special topographic map of Greasy Cove serves as a base for a detailed geologic map of that area displaying typical Paleozoic stratigraphy and plunging anticlinal structure in the Ridge and Valley Province in Alabama. This map is published on the scale of 1:31,680, or 2 inches to 1 mile, and constitutes Plate 2 of the illustrations. As this is the only complete geologic map in the report, it will be described in the text as representative of the geology of the whole area under discussion.

The 30-minute, 1:125,000 scale, topographic maps serve as bases for delineation of the iron ore outcrops in the remainder of northeastern Alabama. These maps, Plates 3 to 14, cannot be expected to be perfect, particularly those with 100-foot contour intervals. The topography, with the exception of the Fort Payne and Anniston quadrangles, is of the reconnaissance class; no township, range, or section lines are shown on any of them, and the culture (roads, bridges, building, etc.) is badly in need of revision. Although unsatisfactory, these bases are the only ones available and they have been utilized in the best manner possible in view of their imperfections. Figure 1 shows the distribution of the maps, Plates 2 to 14, with respect to the quadrangular topographic maps of northeast Alabama. All of the original base maps mentioned above may be purchased from the Director, United States Geological Survey, Washington 25, D. C.

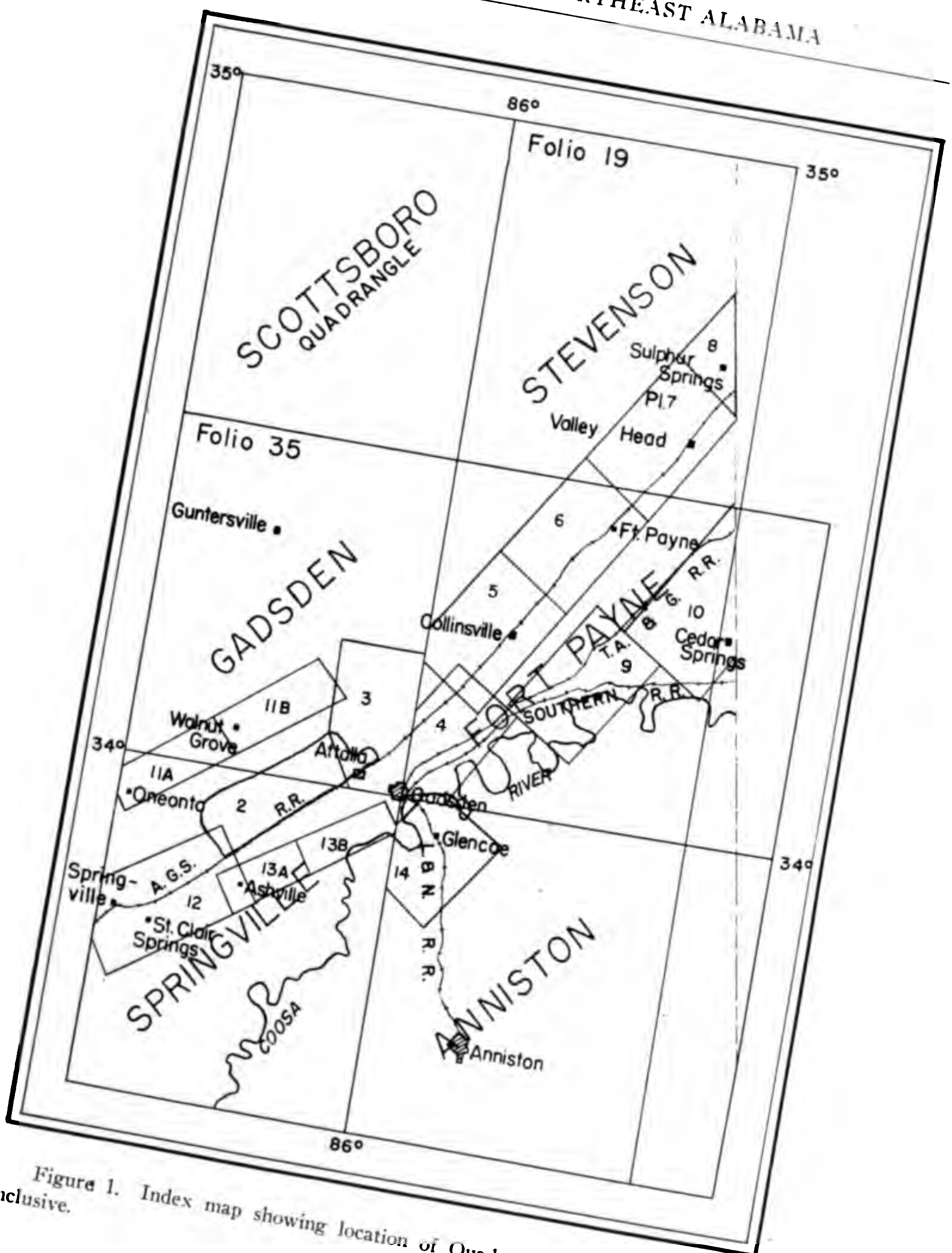

Figure 1. Index map showing location of Quadrangles and Plates 2 to 14 inclusive.

In the field it was found advantageous to record information, so far as available, according to the following schedule. The data most difficult to secure were in relation to the location of the land by sections, townships, and ranges, because the topographic maps, except that of Greasy Cove, were not supplied with land lines. It was also difficult to ascertain ownership of land, especially in places which were sparsely settled.

Information schedule for Bedded Iron Ore Deposits

1. Date
2. Location: Tie point
   Geographic
3. Name and address (a) Owner of proprety
   Operator of property
4. Stage of prospecting or development
5. Ore: Character; type; appearance; principal minerals; principal impurities; probable grades; proportion of ore and waste rock; get typical hand specimens and samples for analyses
6. Topographic situation: Position; altitude above nearest important drainage and above sea level
7. Outcrops or surface evidence of ore
8. Range and average thickness of beds; dip, strike, and other structural features; make sections
9. Overburden: Character and thickness
10. Associated rocks: Age; character; dip and strike; general structure; relation to ore deposits
11. Ore available: Blocked out (measured); estimated indicated, inferred, potential
12. Conditions affecting mining: Accessibility; topography; sites for buildings, washers, dumps, settling basins; water supply, timber, fuel, distance to highways, railroads, and places of consumption
13. Methods of mining, washing, transportation, use of ore
14. Secure representative chemical analyses of ores or products, property maps, engineers reports, records of production, if available
15. Remarks

GEOGRAPHY

Location and area.—The bedded hematite ore of northeast Alabama is comprised within a roughly elliptical area of about 1,700 square miles beginning at the Georgia State line near Sulphur Springs and extending southwestward along Sand Mountain west of Wills Valley to beyond Oneonta in Murphree's Valley, thence eastward through Springville and Glencoe, thence northeastward to the Alabama-Georgia line near Gaylesville. Within this area are parts of Blount, Calhoun, Cherokee, DeKalb, Etowah, Marshall, and St. Clair counties. Consideration is also give in this report to portions of the plateau counties lying toward the west and southwest in the Warrior Coal Field, below which the Red Mountain formation extends without, however, giving definite promise of containing valuable iron ore. The area does not include Birmingham, as that district has already been described in a bulletin and folio issued by the United States Geological Survey.

Physiography

The Paleozoic area of northeast Alabama, which contains the bedded deposits of red iron ore under discussion, is within the physical division of the United States known as the Appalachian Highlands. Johnston[5] has outlined the subdivisions of the Appalachian Highlands in the southeastern United States, particularly in Alabama. The two principal subdivisions of this highland of present concern are the Cumberland Plateau and the Valley and Ridge Provinces.

Locally within the Cumberland Plateau are the ridge-like remnants of the plateau—Blount Mountain, Chandler Mountain, Lookout Mountain, and Sand Mountain—with Murphrees, Browns (or Tennessee River), and Wills Valleys incised in them. The Valley and Ridge Province lies to the southeast of Chandler and Lookout Mountains and comprises a few ridges lying east of Lookout Mountain such as Shinbone, Tucker, Dirtseller, Weisner, the Coosa Valley, and the Coosa Valley Ridges, such as Canoe Creek Mountain, Dunaway-Elliott Mountain, Beaver Creek, Greens Creek and Colvin Mountains. The plateaus originally were relatively broad and have been developed on hard sandstone forma-

[5]Johnston, William Drumm, Jr., Ground Water in the Paleozoic Rocks of northern Alabama: Geol. Survey of Ala. Special Report 16, Pt. 1, 1933, pp. 9-23.

tions that lie nearly horizontal or are folded gently into shallow synclines. The valleys incised into the plateaus have been developed along more sharply folded anticlinal axes which have brought limestone or dolomite formations to the surface where they have been cut into by solution and erosion. Bordering the anticlinal valleys, generally with narrow valleys between them and the plateau escarpment, are sharp narrow ridges developed on resistant sandstones moderately to steeply tilted on the flanks of the anticlines. These narrow ridges generally contain the outcrops of the Red Mountain formation that carries the red hematite ore. Examples of such ridges are Red Mountain, on the southeast side of Wills Valley, and Shinbone Ridge on the southeast side of Lookout Mountain. In these ridges the ore beds, unless overturned, are either vertical or dip toward the plateaus, but unfortunately for the exploitation of the ore beds there are many places where the iron ore-bearing formation has been dislocated below the surface or where its outcrop has been cut out by faulting. The narrow valleys separating the ore-bearing ridges from the plateaus are generally surfaced with sand or with sandstone debris derived from formations that have disintegrated and been let down by the solution of underlying limestone and are called "sand valleys," "poor," or "back" valleys.

The broad valley of the Coosa River is developed on shale and limestone. North of this valley near the eastern border of the State, Tucker and Dirtseller Ridges are developed on folded strata of the iron-bearing formation and southeast of the valley are structural ridges of quartzite and sandstone, some of which are sparingly iron bearing.

The altitudes in northeast Alabama range from less than 500 feet along Coosa River to 1,900 feet at the summit of Mt. Weisner. Tennessee River at Guntersville is a little less than 600 feet above sea level. The valleys generally range in altitude from 500 to 750 feet and the plateaus from 1,000 to 1,850 feet. Wills Valley, which is long and narrow, reaches an altitude of 1,027 feet at Valley Head where the divide occurs between it and the valley of Lookout Creek. The town of Fort Payne, which is in the upper part of Wills Valley, is thus 924 feet above sea level. Downtown Gadsden is about 600 feet in altitude. The altitudes of some of the other well-known topographic features are as follows: Lookout Mountain near Gadsden is 1,124 feet and east of Valley Head it is 1,847 feet; Sand Mountain ranges from 1,124 feet at Albertville to 1,785

feet in the northeast corner of the State; Blount and Chandler Mountains reach altitudes of about 1,500 feet; Red Mountain more than 1,250 feet; Shinbone and Tucker Ridges more than 1,050 feet; Dunaway Mountain, 1,200 feet; Colvin Mountain, 1,250 feet; and Beaver Creek Mountain, 1,200 feet.

Drainage.—The area is drained by four of the principal river systems of northern Alabama, viz., the Coosa, the Tennessee, the Warrior, and the Cahaba. Certain of the tributaries of Coosa River have grown to the size of small rivers and in their lower courses have developed stream meanders so that in seasons of heavy rainfall flood conditions sometimes prevail. Such streams are Wills and Big Canoe Creeks and the Chattooga River. The Coosa River, on which south of this region there are several dams for production of power, eventually may be made navigable for light-draft boats to above Gadsden.

Climate.—The climate of northeast Alabama is temperate and equable, the average annual temperature at Gadsden being 61.5° F. There is a slight difference between the temperature in the valleys and on the plateaus. The warmest months are June, July and August, when the monthly mean temperatures range between 74.8° for June at Valley Head and 79.6° for July at Gadsden and the coolest months are December, January, and February, when temperatures range between 40.5° in January at Valley Head and 44.2° in December and February at Gadsden. The mean temperature in degrees Fahrenheit in Gadsden for 33 years has been as follows, according to U. S. Weather Bureau reports quoted by Johnston,[1] page 4.

January	43.1	April	60.7	July	79.6	October	62.8
February	43.7	May	69.6	August	79.1	November	51.4
March	53.1	June	77.0	September	74.2	December	43.9

Severe cold weather seldom occurs or continues more than a few days. Snow, likewise is uncommon but occurs in high places in the northern counties two or three times during the winter and melts within a short time. The summers are no hotter than in many states farther north but afford a longer growing season for crops, averaging more than 200 days. The mild climate favors agriculture and industry by its year-round working season and by permitting more reasonable costs for housing, clothing, and fuel for workers than in more northern latitudes.

Rainfall is usually ample for agricultural needs and is generally well distributed throughout the year. The winter, spring, and early summer months usually receive the greatest rainfall, September, October, and November being generally the driest period. In this part of the State the annual precipitation appears to be about 53 inches.[2]

Soils, crops and vegetation.—The soils in the higher lands are generally derived from sandstone and shale and in the valleys from limestone and chert formations. Certain types of fertilizers are used with success on practically all soils. All the counties in northeast Alabama raise cotton, wheat, rye, oats, corn, soy beans, red clover and other hay plants, garden vegetables, sorghum, apples, pears, plums, cherries, grapes and other fruits of a temperate climate. Dairying is increasing in importance.

Northeast Alabama was once covered with forests. The virgin timber has mostly been logged off and in places the land has been logged a second or third time. Sawmill operations in this region now are generally on a moderate scale. Shortleaf pine, loblolly pine, and hardwood are still found and in Calhoun County longleaf pine makes its appearance.

Population and industries.—Northeast Alabama is a well-settled region containing an average of about 67 persons per square mile in 1940. The population is essentially rural, although with the growth of industry it is slowly becoming more urban. The most populous County is Etowah, with 72,580 inhabitants in 1940, largely in Gadsden with 36,975, Alabama City (now a part of Gadsden) 8,544, and Attalla, 4,885 in that year. Other towns in the area whose population ranges between 350 and 4,500 are Stevenson, Scottsboro, Guntersville, Oneonta, Altoona, Valley Head, Fort Payne, Collinsville, Springville, and Ashville. Certain of these towns are county seats. All of them serve as local trading centers and at most of them and at many smaller places there are cotton gins. Cotton textiles mills are operated at many of the larger places thus utilizing at home the country's staple crop.

Few of the towns in northeast Alabama now number mining among the local industries. In earlier days iron ore was mined at

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[2]Alabama Industrial Board, Birmingham, Ala., Sept. 1929, p. 144.

several places in Wills Valley and its northward extension as at Sulphur Springs, Battelle, Fort Payne, Collinsville, Portersville, Crudup, and Attalla, and in other localities near Oneonta, Springville, Gadsden, Round Mountain and Gaylesville. Historical references to some of these developments are published elsewhere.[3] Mining of coal is active at present and has long been carried on at Altoona. The largest single industry in the region is the manufacture of pig iron and steel and of many products fabricated from these metals at Gadsden and Attalla.

The manufacture of steel is carried on by the Republic Steel Corporation at its Alabama City plant, within the city limits of Gadsden in a modern and complete steel mill. This company produces all its raw material within Alabama, its red iron ore in the Birmingham District, its brown iron ore at various places, its coal at Altoona, Sayreton and Virginia, and its fluxing stone is quarried at Cobb City.

Coal.—The Coosa, Cahaba, and Warrior coal fields lie on the borders of northeast Alabama and the Plateau coal field lies within its borders. The Warrior Coal field contains the coking coal. The study of the iron ores has involved no survey of the fuel or power situation and so the reader is referred to papers on the coal fields listed in the references, pp. 16-19.

Natural Gas.—The newest source of fuel that has become available in northeast Alabama is natural gas piped from Louisiana and neighboring fields. It is understood that this gas in finding a ready acceptance for industrial and domestic uses. The Republic Steel Corporation is reported to use natural gas in its open-hearth furnaces at Gadsden.

Water.—An abundant supply of water for domestic and industrial purposes is one of the natural blessings of northeastern Alabama. The supplies of ground water have been described by Johnston[4] and data on surface waters are available in another State publication.[5]

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[3]Armes, Ethel, The story of coal and iron in Alabama: University Press, Cambridge, Mass., 581 pp. 1910.

[4]Johnston, Wm. D., Jr., Ground water in the Paleozoic rocks of northern Alabama: Geol. Survey of Alabama, Special Report No. 16, 1933.

[5]Hall, B. M., and Hall, M. R., Second Report on water powers in Alabama: Geological Survey of Alabama, Bull. 17, 1916.

It is stated by the Chamber of Commerce of Gadsden that the minimum flow of the Coosa River at Gadsden is 2,000 cubic feet per second, and that the waters of this river are remarkably free of boiler-scale forming minerals or other substances deleterious to industrial use.

It is also pointed out that Gadsden is the birthplace of the Alabama Power Company and that Gadsden has available at low rates more than 1,000,000 horsepower of electric energy generated at several hydroelectric plants located on the Coosa and other nearby rivers of Alabama.

Transportation facilities.—The iron-ore bearing areas of northeast Alabama are for the most part easily accessible. Railroads parallel the ore outcrops of the Lookout Mountain Plateau, the Alabama Great Southern on the northwest, and The Tennessee, Alabama, and Georgia on the southeast border, both lines within a fraction of a mile to a little more than a mile distant at most points. The Alabama Great Southern extends southwest from Attalla within short distances of the ore-bearing ridges that flank Chandler and Blount Mountains. The Southern Railway skirts the east border of Shinbone Ridge from Gadsden to Leesburg, then extends eastward past Round Mountain and Tuckers Ridge to Rome, Ga. The Southern Railway also extends down the west side of Browns Valley from the State line to Scottsboro and connects at Huntsville by rail and car-ferry to Guntersville with the branch of the Nashville, Chattanooga, and St. Louis Railway which crosses Sand Mountain from Guntersville to Attalla. The Louisville and Nashville Railway from Anniston to Gadsden crosses certain iron-bearing ridges and from Gadsden to Birmingham passes through Greasy Cove and Murphrees Valley, incidentally serving the Gadsden-Attalla industrial district. The Seaboard Air Line crosses the extreme southern part of the district, tapping coal rather than ore fields. Highways are generally good and have served for motor-truck haulage of iron ore from mines to the railroads but heretofore it has been more generally the practice to build short standard-guage or narrow-guage spurs directly to the mines. A feature of future interest is the projected improvement of navigation on Coosa River involving the development of a 9-foot channel from Rome, Georgia, to the Gulf of Mexico, which would give northeastern Alabama a water outlet to the sea.

OUTLINE OF THE GEOLOGY

The rocks exposed in the northeast Alabama iron ore field are of Paleozoic age, and with breaks in sequence, range from Cambrian to Pennsylvanian. In places recent surficial deposits overlie most of the Paleozoic formations. The rocks are all of sedimentary origin and have not been subjected to metamorphism in the ordinary sense of that term, although most of formations have suffered minor alterations through structural deformation, the action of circulating waters, and weathering agencies. The percentage of fixed carbon in the coal beds in certain areas has been slightly increased.

The rocks with which this report is most concerned are comprised within the Red Mountain formation, of Silurian age, and inasmuch as there is a great deal of geologic literature, some of it fairly recent, dealing with the general geology and with the iron ores of the region, including adjacent parts of Georgia and Tennessee, the formations not closely associated with the ore beds will not be described in detail. Moreover, in the chapter on Greasy Cove, pages 28-44, all the formations which occur in that area and which comprise nearly all those exposed in northeast Alabama are described briefly, thus eliminating the necessity of giving them further consideration in this outline.

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General Structure

On the subject of general geologic structure only a brief outline need be given for the area at large as under the descriptions of iron ore outcrops in the various subdivisions of northeast Alabama will be given more particulars concerning the local structure of the rocks associated with the ore beds.

It has been pointed out in the text on Physiography that the land forms are closely dependent upon the underlying rock structure, and conversely, the broader features of the rock structure can readily be interpreted from the land forms. The broad areas and remnants of the Cumberland Plateau are generally underlain by rocks that lie nearly horizontal or have been gently folded into synclines but there are several sharp narrow anticlines that separate the broader synclinal structures. On the borders of these anticlines the strata have been tilted from moderate angles to vertical or overturned and are in many places bordered by faults. Sections A-A, B-B, C-C, and D-D, in Plate 2 of this report will serve to illustrate these structural relations.

The broad synclinal areas are represented by the outlying hills capped by rocks of the Pottsville formation northwest of Brown's Valley (Tennessee River), and Sand, or Raccoon Mountain, Lookout Mountain, and Blount Mountain. The narrow anticlines are exhibited in Browns, Wills-Lookout, and Murphrees Valleys. The border between the Cumberland Plateau and the Coosa Valley and Ridge area is marked by more complicated structure, such as more profound and more closely spaced faults, and in the Valley and Ridge area faults have repeated narrow areas of certain formations and in places have thrust earlier over later formations.

The beds of red iron ore generally crop out in narrow ridges on the flanks of the anticlinal arches and dip toward the broad synclines. Theoretically the red iron ore beds should extend continuously underneath the synclinal Lookout, Sand, and Blount Mountains from one margin to the other, but this ideal condition may not exist. There is no knowledge based on experience to prove the continuity of the ore beds below the plateaus. Mining along the margins has nowhere been able to penetrate as far as a point directly below the escarpment. This has been due to more

than one difficulty. In places the ore bed has been so badly crushed and shattered by movements of the rocks that the ore was of little value and water entered the mine in too large volume; in other instances the ore bed was lost entirely by faulting, and in others the ore deteriorated or thinned out to such an extent down the dip as to become unworkable.

Drill holes have been put down in the back valleys between the ore-bearing ridges and the plateau escarpments north of Gadsden and southwest of Attalla where the ore should have been encountered at moderate depth, but not even the ore-bearing formation was reached, indicating the presence of unsuspected faults. Structural relations, therfore, have an important bearing on the availability of the iron ore. Original deposition also has an important bearing on the occurrence and on the character and thickness of the ore beds. Observations along the outcrops of the ore beds show great variation—even disappearance—along their strike and so it may be expected also in the direction of dip. It is for this reason that it is most logical to believe that the ore beds are lenticular in shape and limited in extent, that in places two lenses may overlap in a given section while in others no ore at all may be found. It is also illogical to construct a structure section showing the Red Mountain formation as carrying beds of ore continuously below the plateaus across distances of 5 to 20 miles without serious question as to the facts. Only thorough core drilling can determine this question.

Stratigraphy

A generalized section with brief notes on the character of the rocks in northeast Alabama, after Butts (p. 80) and Johnston (p. 8) is given below. By reference to the original tables which include a time scale and sections for various parts of Alabama it will be seen that not all the formations given in the table herewith are present at any one place in northeast Alabama. Reference to the geological map accompanying Special Report 14 of the Geological Survey of Alabama will make clear the general distribution of all the formations and Plate 1 of this report will show the distribution of the Red Mountain formation. The distribution of the outcrops of the beds is primarily dependent on the geologic structure and

the erosional features. The Cambrian and Ordovician(?) rocks occupy the axes of anticlinal valleys with Ordovician, Silurian, Devonian, and Mississippian rocks on the limbs of the anticlines and Pennsylvanian rocks in the broad synclinal uplands.

Generalized section of rocks in northeast Alabama

System	Series	Formation	Character	Thickness--Feet
	Penn.	Pottsville	Shale, sandstone	9,000(max.)
Carboniferous	Mississippian	Parkwood	Shale, sandstone	400-2,200
		Floyd	Shale, a little sandstone and limestone	1,200-2,000(?)
		Pennington	Shale, sandstone, limestone	50-450
		Bangor	Limestone	100-700
		Hartselle	Sandstone	5-200
		Gasper	Limestone and marl	75-150
		Ste. Genevieve	Limestone, oolitic	10-100
			Limestone, coarse grained	175(max.)
		Tuscumbia { St. Louis, Warsaw }	Limestone, thick-bedded, coarsely crystalline	15-200
		Fort Payne	Chert and limestone	100-200
Devonian		Chattanooga	Black shale	2-20
		Frog Mountain	Thin sandstone	20-50
			Sandstone	6-350
Silurian		Red Mountain	Sandstone, shale, iron ore	400-700
Ordovician		Chickamauga: Sequatchie	Limestone, sandy	150(max.)
		Chickamauga: Little Oak	Limestone	50-500
		Chickamauga: Athens	Shale and limestone	10-300
		Chickamauga: Lenoir	Limestone	500(max.)
		Chickamauga: Attalla	Conglomerate of chert and quartzite	5-50
		Mosheim	Limestone	50(max.)
		Odenville	Limestone, cherty	50
		Newala	Limestone	1,000
		Longview	Limestone, cherty	500±
Cambrian or Ordovician		Chepultepec	Dolomite, cherty	1,100(max.)
		Copper Ridge	Dolomite, cherty	2,000(max.)
		Bibb	Dolomite	500(max.)
		Ketona	Dolomite	250-600±
		Brierfield	Dolomite	1,500(max.)
Cambrian		Conasauga	Shale, limestone	500-1,900
		Rome	Shale, sandstone, limestone	700-2,250
		Shady	Limestone, dolomite	500-1,200
		Weisner	Quartzite, shale	5,500(max.)

SILURIAN ROCKS

Red Mountain formation

Character, thickness, correlation.—In northeast Alabama the Red Mountain formation, the sole representative of the Silurian system, consists, at and near the surface, of beds of sandstone, shale, and iron ore. Below the water-table the beds of sandstone are generally more or less calcareous. Probably originally they were calcareous but near the surface much of the calcium carbonate has been leached out by surface waters. In north central and northwest Alabama the formation is comparatively thin and consists largely of limestone, which is more or less ferruginous in places.

The thickness of the Red Mountain formation is variable. In the north central and northwest parts of the State it crops out in but few places and information is best obtained from drill records. According to the most reliable records of holes drilled for oil in the Plateau counties the thickness ranged generally from 180 to 425 feet, although, due to uncertainties in logging of the wells a few records showed smaller and others much larger footages. In Sand Valley, Wills Valley, and east of Lookout Mountain measurements ranging between 430 and 658 feet have been obtained, mostly from surface observations.

In line with the effort to avoid duplication of printing the reader is referred to the notes on the Red Mountain formation and on the red iron ores in the Chapter on Greasy Cove in this report, pages 38 and 44. No especial paleontological studies for the purpose of correlation of parts of the Red Mountain formation have been made during this economic survey, but interesting facts have been observed and recorded that in the future may be helpful in explaining some of the anomalies that do occur. However, the investigation by the geologists of the Tennessee Valley Authority in the Guntersville Reservoir have brought out some significant correlations that have an important economic bearing, and it is recommended that the chapter entitled "Paleontologic Correlation of the members of the Red Mountain formation in the Guntersville Reservoir" by Robert M. Ross, incorporated into this Report, pages 319-333, be read carefully. The description of the Red Mountain formation by Chas. Butts in Special Report 14 of the

Geological Survey of Alabama, pages 133-141, also will be found of much interest in this connection.

General Distribution

(Plate 1).

The Red Mountain formation in northeast Alabama crops out in long, roughly parallel, more or less continuous strips. The width of outcrop of these strips in most places is narrow because of the position of the strata on the foothill ridges. The outcrops are confined largely to foothill ridges along the narrow anticlinal valleys between the synclinal plateaus of Lookout, Blount, Chandler and Sand Mountains. Other outcrops occur east and southeast of Lookout and Blount Mountains. The strips of Red Mountain formation with few exceptions strike northeast paralleling the axes of the main folds.

Springville-Greasy Cove.—(Plates 2 and 12). A strip of the Red Mountain formation generally paralleling the southeast sides of Blount and Chandler Mountains begins southwest of the area included in this report and extends past Springville nearly to Attalla. The outcrop varies in width from place to place. It is unusually wide about 2 miles northeast of Chandler Mountain where it extends completely across the axis of the syncline. Faults interrupt the continuity of the outcrop in places, and in other places cause duplication of outcrops. From place to place the strata have steep dips because of faulting. About 2 miles west of Attalla the Red Mountain formation is exposed around the northeast end of the Chandler Mountain syncline and extends into Greasy Cove and Wills Valley.

At the head of Greasy Cove at the southwest end of anticlinal Wills Valley the axis of the anticline plunges gently below the surface to the southwest and the strata have been dislocated for about half a mile by a strike fault. Differential erosion has produced on the periphery of the Cove a U-shaped foothill ridge that is known particularly on the southeast border of the Cove as Red Mountain. In most places the ridge is capped by strata of the Red Mountain formation. The strip extends from about 2 miles west of Attalla, southwestward barely into St. Clair County, swings around the head of the Cove and extends northeastward

to end against a fault near Littleton in Etowah County. This strip of Red Mountain formation has received more than ordinary attention because the thickness of the iron ore beds which crop out in the Cove is greater in places than anywhere else outside of the Birmingham District.

Wills Valley.—(Plates 2-8). The Red Mountain formation in Wills Valley extends northeastward through Etowah and DeKaub counties, to the Georgia State line. The area comprises 2 parallel strips, about 3½ miles apart, separated from each other by anticinal areas of older rocks.

Beginning at Attalla in Moragne Mountain a strip of the Red Mountain formation forms a foothill ridge known as Red Mountain which parallels the northwest border of Lookout Mountain to the Georgia State line. The continuity of this ridge is broken by relatively few gaps and the outcrop of Red Mountain strata extends uninterruptedly throughout the entire strip. The beds, for the most part, dip moderately southeast toward Lookout Mountain.

On the opposite, or northwest, side of Wills Valley the Red Mountain formation crops out with steep northwestward dips in a low ridge, called "West Red Mountain". In some places these strata have been overturned or interrupted by faults. About 4½ miles north of the northeast end of this strip and about 5 miles north of Sulphur Springs, Alabama, the Red Mountain formation is exposed for about 1 mile in Pudding Ridge, the southwest end of a plunging anticline which enters Alabama from Georgia. (Plate 8.)

Shinbone Ridge.—(Plates 3, 4, 9 and 10). Beginning at the great eastward fault at the southwest end of Lookout Mountain at Gadsden Shinbone Ridge extends northeastward along the southeast border of Lookout Mountain as far as the Georgia State line. The ridge is generally narrow. In some places it is a prominent topographic feature, with the Red Mountain formation cropping out on the southeast slopes, but in other places the ridge loses its identity, and the Red Mountain strata, where present, crop out on a series of low ridges, hills, and knobs. The entire strip of Red Mountain formation southeast of Lookout Mountain is bordered by, or lies just northwest of, a fault zone. As a result

the strata tend to have steep dips to the northwest but in a few places have reversed dips to the southeast. The Red Mountain strata are eliminated entirely by a fault for about 2 miles near Blue Pond, Cherokee County.

East of Shinbone Ridge.—(Plates 4, 9, 10). Leeth Mountain, about 9 miles northeast of Gadsden in Etowah County has a small outcrop of the Red Mountain formation against which strata of the Conasauga formation have been faulted. In Cherokee County the Red Mountain formation crops out on Tucker Ridge and its outlier, Round Mountain, which lies about 3 miles southwest of the extremity of Tucker Ridge, and strata of this formation crop out also about 3 miles east of Gaylesville on Scraper Mountain. Tucker Ridge and Scraper Mountain are synclinal in structure, and the Red Mountain formation dipping gently southeast on the northwest limbs of the synclines forms prominent outcrops. The southeast limbs of the synclines are cut off in part by faults.

Coosa Valley Ridges.—(Plates 12, 13-A and 13-B, 14). In the western part of the district included under Coosa Valley Ridges the Red Mountain formation crops out on several short ridges and isolated mountains which are the eroded remnants of folds cut off by thrust faults. In this group in St. Clair County is a short unnamed ridge which extends southeast from Springville. Southwest of Gadsden are Cedar Mountain, Canoe Creek Mountain, and Dunaway-Elliott Mountain, all of them bounded on the southeast by the Cahaba fault.

The most southeasterly outcrops of the Red Mountain formation are on a long ridge which begins near Odenville in St. Clair County, extends northeasterly for over 40 miles, and ends about 12 miles east of Glencoe in Calhoun County. At its southwest end the ridge is known as Oak Ridge, and other parts to the northeast are known successively as Beaver Creek Mountains, Greens Creek Mountain, and Colvin Mountain. The beds in this ridge in most places dip southeast at low angles, but near Glencoe faults disrupt the strata and the dips are variable. East of Glencoe the ridge trends almost directly east and the beds dip to the south.

Murphrees Valley.—(Plates 11-A and 11-B). Murphree's Valley begins in Etowah County about 9 miles northwest of Attalla and extends southwestward past Oneonta in Blount County

and beyond the limits of the area considered in this report. This valley has been incised along the axis of an unsymetrical anticline which plunges to the northeast under the strata of the Sand Mountain plateau. Strata of the Red Mountain formation crop out in a low ridge along the northwest side of the Valley, on the southeast side for a short distance, but from a point about 2½ miles east of Oneonta to a point near Aurora the formation is cut out by a fault.

Browns Valley.—(Plate 1.) The most extensive outcrops of Red Mountain formation in northeast Alabama are on the borders of the anticlinal Browns Valley. These strips extend from the Tennessee State line southwestward to near Brooksville, Blount County, where the formation plunges below the surface. Near Blountsville the Red Mountain strata appear in 3 small dome structures which are on the strike of the axis of the anticlinal fold.

The strip of Red Mountain formation on the southeast side of Browns Valley is continuous and unbroken by faults. At several places the strip is crossed by the Tennessee River. From the vicinity of Brooksville to Scottsboro the strip on the northwest side of the valley is broken by only one fault but from Scottsboro to the Tennessee State line the formation is entirely eliminated from the section by another fault.

Plateau Counties.—The plateau highlands have no outcrops of the Red Mountain formation. Drill records have penetrated the formation in many places, as described in one of the later chapters of this report. Rocks exposed in the valleys of northern tributaries of the Tennessee River in Lauderdale and Limestone Counties that have been determined to be of Silurian age are predominantly of limestone—no iron ore is present.

The general distribution of the outcrops of the Red Mountain formation in northeast Alabama is well displayed on the geologic map of Alabama issued by the Geological Survey of Alabama in Special Report 14, and they are shown on a smaller scale in Plate 1 of this present report.

GREASY COVE

(Plate 2)

General Statement.—The Greasy Cove district is a roughly rectangular area in northeast Alabama, comprising about 90 square miles, which lies mostly west and southwest of Attalla and St. Clair Counties. The long side of the rectangle is bounded on the southeast by the main line of the Alabama Great Southern Railroad. The crest of Blount Mountain is its northwest boundary. The southwest and northeast boundaries are irregular, as they are formed mainly by State Highway No. 38 and U. S. Highway No. 241, respectively. Greasy Cove,[1] itself, is a narrow valley between Chandler and Blount Mountains. Several beds of hematite crop out on the borders of the cove. One of these is thicker in places than any other bed of hematite in northeast Alabama outside the Birmingham district, and all of the beds are favorably situated for prospecting and mining. These facts, in addition to long continued geologic and economic interest in the deposits, justified the issuance of a preliminary report[2] on the bedded red iron ores of the district in 1933.

The U. S. Geological Survey completed a special topographic map of the Greasy Cove district in 1938, and on this base Thomas G. Andrews made a detailed geologic map, Plate 2, of this Report. Greasy Cove is the only area of the several considered in this report for which a detailed, up-to-date base is available. The stratigraphy is similar to that of the other iron ore-bearing areas of northeast Alabama. For these reasons the Greasy Cove district is described in detail as representative of the regional geology.

Topography

Greasy Cove lies in the Cumberland Plateau part of the Appalachian Plateau.[3] Relief in the area is moderate; the maximum difference in altitude is about 1000 feet.

[1]The name is said to have been derived from the greasy looking scum of iron oxide which appears on water seeping from beds of iron ore on the borders of the cove.

[2]Burchard, Ernest F. Iron Ore in the Red Mountain Formation in Greasy Cove, Alabama: U. S. Geological Survey, Circular 1, 49 pp., 1933.

[3]Johnston, W. D., Jr., A revision of physical divisions of northern Alabama: Washington Acad. Sci. Jour. vol. 22, no. 8, p. 220, 1932.

The most prominent topographic features are the synclinal plateaus of Blount Mountain, Chandler Mountain, and the valley which lies between them known as "Greasy Cove". Minor features are the foothill ridge in which beds of red iron ore crop out, Moragne Mountain in the northeastern part of the district, and the topographic basin northeast of Shores Gap. The mountains, ridges, and valleys are the result of differential resistance to weathering of various folded, and here and there faulted, sedimentary rocks. The topography reflects the lithology and structure of the underlying strata. (See Figs. 2A and 2B.)

The strata underlying Greasy Cove have been folded to form a low anticline in line with the axis of the anticlinal Wills Valley. The axis of this fold here plunges southwest at a low angle under the Blount Mountain-Chandler Mountain plateau thus producing the Cove which thus becomes the southwestern terminus of Wills Valley. The central part of Greasy Cove is a maturely dissected region of slight relief composed of hills and valleys in which the maximum difference in altitude is about 300 feet.

The greater part of Blount Mountain syncline lies northwest of the Greasy Cove area so that only the crest and steep southeast slopes of the mountain appear on Plate 2. Blount Mountain has a fairly level narrow crest whose uniformity is broken from place to place by streams and gaps. Roads cross the mountain at Autreys, Hyatt, Tumlin, and Gregory Gaps, but abandoned roads lead to Battle Gap and other gaps without name. The mountain trends generally northeast-southwest except in the southwestern part of the area where it bends to the south and is separated from Chandler Mountain only by Hyatts Gap.

Chandler Mountain, an elliptical-shaped outlier of Blount Mountain, is residual from the erosion of the syncline southeast of Greasy Cove. The top of the mountain has been eroded to form a shallow topographic basin with a gently rolling surface. Drainage of the basin goes into Gulf Creek whose steep re-entrant valley breaks the comparatively level crest line of the mountain on its southeast side. The sandstone capping the mountain weathers to form steep cliffs on all sides.

A low ridge, known locally as Red Mountain, forms a foothill belt bordering Greasy Cove on three sides, with the open side to

Fig. 2A. View south-southwest to head of Greasy Cove from top of Blount Mountain near Tumlin Gap.

Fig. 2B View southeast across Greasy Cove from top of Blount Mountain near Tumlin Gap. Shows Chandler Mountain on skyline with two ridges of Red Mountain in middle ground.

the northeast. The less prominent northwest prong of the ridge, with moderately steep slopes, which is separated from Blount Mountain by a narrow valley, begins about 1 mile west of the road that extends from Walnut Grove to Attalla and Gadsden. It is cut by Schoolhouse, Gilliland, and McLendon Gaps. The more prominent southeast prong, extending about 7 miles beyond the northeast end of Chandler Mountain, terminates about a quarter of a mile west of Moragne Station. This part of the ridge, separated from Chandler Mountain by a narrow valley in part of which Little Canoe Creek flows, has steeper slopes toward Greasy Cove than toward Chandler Mountain. The foothill ridge is broken from place to place by notches or gaps, including Brothers Mill, Moodys, Garignes, and Turleys Gaps. A discontinuous and still less prominent ridge, similar to the one above described, begins about three-quarters of a mile southwest of Moragne Station and extends southwestward along the southeast side of Chandler Mountain to the area boundary near Whitney at State Highway No. 38.

Moragne Mountain is the V-shaped southwestern end of the long foothill ridge, Red Mountain, mentioned elsewhere in this report in connection with descriptions of iron ore beds in Wills Valley, paralleling Lookout Mountain on the northwest from the Georgia line to Attalla, of which only a 2-mile segment is included in the Greasy Cove area. Moragne Mountain has moderately steep slopes and a relief of about 500 feet. The two prongs of the mountain form a small V-shaped valley opening eastward, at the mouth of which lies a large part of the town of Attalla.

Northeast of Shores Gap the higher Red Mountain ridge on the northwest and a lower ridge on the southeast bound a roughly elliptical area about 3 miles long. The central part of the area has been eroded to form an unsymmetrical topographic basin, which has been dissected by small creeks, and most of the surface slopes toward the southeast. The maximum difference in altitude between the bottom of the basin and the highest parts of the encircling ridges is about 525 feet.

Geology

STRUCTURE

The prominent structural features of the Greasy Cove area are the narrow southwestward plunging anticline in which Greasy Cove is incised, and the elliptical Chandler Mountain syncline, which were formed by the folding of originally flat-lying sedimentary rocks. Faulting, which presumably accompanied the folding, has further disrupted the strata. Topography is so closely related to the positions of the underlying strata that the structure of the district is clearly depicted by the topographic map.

The attitudes of the strata in Greasy Cove vary from place to place in relation to their positions on the plunging anticline and to faults. The strata on the southeast side of the Cove dip generally southeast at angles varying from 20 to 35 degrees. There are no faults of consequence on this side except at the extreme ends of the Red Mountain ridge. At the southwestern end the rocks in the ridge have been thrust northwest along a fault with an apparent throw of less than 100 feet, and at the northeastern end the ridge terminates against a fault which has brought an Upper Cambrian dolomite against sandstone and shale of the Silurian Red Mountain formation.

Strata on the northwest side of the Cove generally have steep northwest dips. Rocks on this entire side have been more or less affected by faulting which in some places has caused reversals in dip and in other places duplication of outcrops. In still other places outcrops have been entirely eliminated.

The Chandler Mountain syncline is a shallow spoon-shaped trough, whose boundaries are more extensive than the main mountain mass. The southeastward dipping strata of the Red Mountain ridge forming the limb common to the Greasy Cove anticline and the Chandler Mountain syncline presumably pass under Chandler Mountain and emerge to form a similar, but lower, ridge on the southeast side. The syncline also extends about 2 miles northeastward beyond the tip of Chandler Mountain to Shores Gap, where erosion of a cross fold has separated completely the strata above the Red Mountain formation in the Chandler Mountain syncline from those in the smaller syncline

northeast of the gap. The small syncline is unsymmetrical with a long northwest limb and a short southeast limb. At the southwest end of Chandler Mountain the formations below the Mississippian Parkwood formation extend beyond the Greasy Cove area and become part of the longer Blount Mountain syncline.

The great east-west fault, against which Lookout Mountain terminates on the southwest, enters the Greasy Cove area near Attalla and brings the Cambrian Conasauga formation against formations ranging in age from Cambrian (Copper Ridge dolomite) to Mississippian (Bangor limestone). The sinuous trace of this low angle thrust fault extends southwestward between the Red Mountain ridge southeast of Chandler Mountain and the southeastern boundary of the area. The effect of the faulting is shown by the development of a fenster in that part of the area. (Pl. 2, SE¼ sec. 8, T. 13 S., R. 4 E.)

The strata in Moragne Mountain were folded into a sharp syncline plunging almost directly east. Minor bending of the limbs of the syncline causes a variation in strike from place to place. The south prong of the mountain ends against the great fault mentioned above, and a small fault with a low hade and little slip apparently lies along the axis of the syncline.

Minor structures in places produce variations in the attitude of the strata of the Greasy Cove area. Small folds with axes parallel to the strike of the greater folds cause sharp changes in dip. Small faults disrupt the strata and in some places have added to the complexities of mining. Local structures are more readily seen in the areas where prospecting and mining have been carried on, and they will be mentioned in the text describing red iron ore beds.

STRATIGRAPHY

The Greasy Cove area contains only Paleozoic sedimentary rocks, with the single exception of a thin bed of volcanic ash, or bentonite, which occurs near the top of the Chickamauga limestone. Sandstone and chert are the most evident and widespread surface rocks, but considerable thicknesses of limestone and shale are thinly concealed by soil, debris, and vegetation in the valleys

and on the hill slopes. Beds of red iron ore are thin and crop out in narrow belts on the foothill ridges.

The strata comprise formations of the Cambrian, Ordovician, Silurian, Devonian (?) and Carboniferous systems. The oldest strata of the district are those of the Conasauga formation which crop out along the southeast side of the area. The next oldest rock is chert derived by weathering from Cambrian or Ordovician dolomites which occupy the central part of Greasy Cove. The younger, and higher, formations are arranged in V-shaped strips on the borders of the Cove. All of the formations appear on the southeast side of the Chandler Mountain syncline, and those up to the Mississippian Parkwood formation crop out in the Moragne Mountain syncline.

Many of the formations exposed in the Greasy Cove area also crop out in the other districts in northeast Alabama in which beds of red iron ore occur. Brief descriptions of their characteristics in the Greasy Cove area are gven below. For more complete descriptions the reader is referred to the Special Report 14 on the geology of Alabama.[4]

Cambrian System

Conasauga formation.—The Conasauga formation is composed of limestone and shale. Thin-bedded limestone, which weathers more slowly than the shale, seems to predominate, and forms most of the Conasauga outcrops. The characteristic "Flatwoods" topography of the formation, developed in the valley regions of Alabama, indicates its presence in the broad belt on the southeastern part of the area.

The limestone of the Conasauga formation is thin to thick-bedded with layers ranging in thickness from half an inch to 3 feet. The usual thickness is about 2 inches. In places many small lenses of limestone occur in the interbedded shale. The larger limestone masses vary in thickness and extent because they are chiefly lenses in the formation.

[4]Adams, G. I., Butts, Charles, Stephenson, L. W., and Cooke, Wythe, Geology of Alabama: Alabama Geol. Survey, Special Rept. No. 14, 312 pp. 1926.

The limestone is gray to blue, predominantly fine grained argillaceous rock, but a few layers are coarsely crystalline. From place to place the thinner beds have been converted into clay layers by loss of calcium carbonate, apparently with little reduction of volume. Many of the beds are crossed by a network of small calcite veinlets filling former fissures in the rock. Fossils are scarce.

Unweathered shale of the Conasauga formation is light to moderately dark gray and sometimes greenish in color. Most of the shale which can be seen has a tan to buff color which is probably due to oxidation during weathering. The shale is thin-bedded, and in places the beds may be of paper thinness. It shatters easily, breaking into minute pieces. Few fossils are contained in it.

In the Greasy Cove area the strata of the Conasauga formation strike generally northeastward, but the beds are overturned and have moderately high dips to the southeast. The attitude varies somewhat for at Attalla in places the strata strike almost directly east and dip steeply northward. The diversity in strike and dip probably is due to thrusting along the fault which crosses the southwest end of Lookout Mountain and whose trace extends southwestward along or near the contact between the Conasauga formation and Cambrian or Ordovician dolomites.

The outcrop width of the Conasauga formation directly across the strike just west of Whitney, in the extreme southeast corner of the Greasy Cove area, is given by Butts as 3600 feet.[5] Butts says "the indicated thickness seems excessive, and suggests repetition by close folding." The Conasauga extends beyond the limits of the district, and no measurement of its actual thickness was feasible.

Cambrian and Ordovician Systems

Copper Ridge and Chepultepec dolomites.—The Copper Ridge and Chepultepec dolomites crop out in the Greasy Cove area but exposures of fresh rock are rare since quantities of residual chert commonly hide them under a thick cover. The chert is spread over a wide area in the central part of Greasy Cove, and is found

[5]Adams, Butts, and others, op. cit., p. 69.

in a narrow strip extending southwestward along the southeast side of the Chandler Mountain syncline. Only three outcrops of dolomite were found in the district, the first along a road in the SW½ sec. 30, T. 11 S., R. 5 E., the second along Browns Creek in the SW¼ sec. 25, T. 11 S., R. 4 E., and the third on the crest of a little hill in the NE¼SE¼ sec. 31, T. 11 S., R. 5 E. The first two outcrops are thought to be of the Copper Ridge dolomite, but the third is Chepultepec as indicated by characteristic chert in the dolomite.

The Copper Ridge and Chepultepec dolomites were grouped together on the State geologic map for stratigraphic and lithologic reasons,[1] because of difficulty in tracing exact contacts in the residual chert, and because the time spent in their separation would have gained no particular advantage.

The Copper Ridge dolomite is generally a massive, fine-grained, gray to blue, thick-bedded dolomite. Single strata are from 2 feet to more than 10 feet thick. Nodules of chert, of practically the same color as the enclosing rock, are present in the dolomite, but are not abundant.

The residual chert of the Copper Ridge dolomite is abundant and characteristic. It is white to tan, dense, tough and angular, even when found in stream deposits. In places the chert is in poorly defined layers of irregular thickness, but usually it is a jumble of pieces and masses of variable shape ranging in size from small fragments to bodies of considerable size. Occasionally laminated pieces are found which may represent parts of cryptozoon forms but, in general, fossils are rare.

The Chepultepec dolomite is a coarsely crystalline, dark-bluish, thin to thick-bedded dolomite. Compact, light gray, thick-bedded limestone may form a part of the formation.

The chert of the Chepultepec dolomite is characteristic also. It is mealy in texture and tends to crumble easily. This chert may occur in masses of variable size or in poorly defined beds. Some of the masses have a worm-eaten appearance.

[1] Adams, Butts, and others: op. cit., p. 80.

The base of the Copper Ridge dolomite is not exposed in the Greasy Cove area, and the base of the Chepultepec dolomite was not recognized because of a lack of fresh exposures. The total thickness of the formations is not known. The maximum outcrop width across the strike of the strata in the central part of Greasy Cove is about 2 miles.

Ordovician System

Chickamauga limestone.—The Chickamauga limestone is composed largely of limestone interbedded with a minor amount of shale. Recognizable also is the basal Attalla chert conglomerate member, and, near the top of the formation, a thin bed of decomposed volcanic ash, or bentonite.

The Attalla chert conglomerate member varies widely in composition from place to place. Its most common phase is a coarse to gritty sandstone with chert pebbles irregularly distributed within the beds. The sandstone is sometimes in well-defined layers varying in thickness from 1 inch to 2 feet but may be in masses of irregular size up to 5 feet thick, apparently lens-shaped. The chert pebbles may be white, green, or blue, are rounded to subangular, and generally are about the size of a pea, but more rarely they may be as long as 1 inch. In other exposures pebbles, similar to those in the sandy phase, are thickly scattered.

The main body of the Chickamauga limestone is composed of gray to blue limestone of variable character. The rock is thin to thick-bedded, dense to crystalline, fossiliferous limestone. In places the limestone may be argillaceous. The beds range in thickness from thin layers up to a maximum of 3 feet. Occasionally outcrops are found on which nodules of dark gray to black and tan chert occur, but such chert is neither abundant nor characteristic.

Near the top of the Chickamauga limestone a bed of waxy, light green, shaly material containing black mica has been found in places. On weathering, this material, whch is thought to be partly decomposed volcanic ash, or bentonite, alters to a tan to gray unctuous clay. One exposure of this material was noted on the northwest slope of Red Mountain in a gully on the trail leading down from Turleys Gap in the NE¼ sec. 16, T. 12 S., R. 4 E. It is from 8 to 12 inches thick.

Good exposures of the Attalla chert conglomerate member and the limestone beds of the Chickamauga limestone may be seen on the borders of Greasy Cove, especially on northwest slope of the southeastern Red Mountain foothill ridge. Another good exposure may be seen on the northwest side of the Cove in the "Bald Hill" (NW¼ sec. 18, T. 12 S., R. 4 E.) where limestone strata of the formation crop out from the bottom to the top of the hill. The most complete section of the Chickamauga limestone in the area is along the old Boaz road, half a mile north of Attalla. Here also the bentonitic bed easily may be found.

The thickness of the Attalla chert conglomerate member of the Chickamauga limestone within the Greasy Cove area is about 50 feet. By calculation of thickness from outcrop width and dip, the limestone part of the Chickamauga has a maximum thickness of about 650 feet, giving a total of possibly 650-700 feet for the entire formation.

Silurian System

Red Mountain formation.—The Red Mountain formation is composed of sandstone, shale, and beds of red iron ore. The sandstones of the formation are commonly of two kinds: gray, fine-grained, resistant, rock, and brown, ferruginous, slightly argillaceous fine-grained material. These beds are from about 1 inch to 3 feet in thickness. The gray sandstone, which is ridge forming, commonly occurs near the bottom of the formation. Shale units of varying thicknesses are interbedded with the sandstone layers. The shale is sandy, micaceous, and tan to brown in color. The sandstone and shale are relatively unfossiliferous, but occasionally units are found which contain numerous brachiopods, corals, and crinoid stems.

Several beds of red iron ore crop out within the Greasy Cove area, and three distinct beds can be traced for considerable distances. The beds, when fresh, are hard, calcareous, fossiliferous, hematite. On weathering they are leached of their calcium carbonate and converted to soft, fossiliferous hematite that is much richer in iron than the hard, calcareous ore. The soft ore has been worked wherever quality and thickness justified, but the hard ores have been left untouched. The beds range in thickness from

about 1 inch to as much as 7½ feet, but in most places are less than 2 feet thick.

There are numerous outcrops of the Red Mountain formation in the foothill ridges, but the characteristics of the formation as a whole are shown by the following detailed section, measured where the beds have a practically vertical position:

Detailed section of the Red Mountain formation in northern part of SW¼ sec. 35, T. 11 S., R. 4 E.

	Ft.	In.
Devonian or Mississippian age		
Chattanooga shale	66	
Silurian		
Red Mountain formation		
Sandstone, heavy-bedded, fine-grained, gray, beds up to 3 feet thick, inter-bedded with shale	180	
Shale, sandy, tan	44	
Ore, soft, fossiliferous, thin clay partings	1	9
Sandstone and shale, brown	6	6
Ore, soft, fossiliferous		10
Sandstone, fine-grained, ferruginous, brown, in beds up to 1 foot 2 inches thick, interbedded with sandy shale	178	
Shale interbedded with sandstone in layers up to 3 inches thick, and including two 1 inch layers of sandy ore	25	
Shale, sandy, with coarse quartz grains	9	8
Total thickness	445	9

Strike N. 60° E., dip about 85° N. 30° W.

The thickness of the formation elsewhere in Greasy Cove as determined from outcrop width and dip is about 480 to 500 feet. These thicknesses compare wth measurements of 605, 629, and 658 feet on the southeast ridge in Wills Valley near Crudup and Fort Payne.

Devonian or Carboniferous

Chattanooga shale.—The Chattanooga shale is black, dense, and fissile. It shatters easily, and fresh outcrops are generally covered with accumulations of small, thin, brittle pieces. In places the shale weathers to a sandy, white to tan, friable shale, and outcrops are frequently obscured by a gray soil.

Outcrops of the Chattanooga shale are common and are generally found in the small saddles between the foothill Red Mountain ridge on one side and the crests of the noses which project at right angles to the Red Mountain ridge on the other. In places where the strata are more distorted, the shale has other positions, and may be found on the crest of the foothill ridge. Good exposures usually are found where gaps have been eroded through the crest of Red Mountain, as at Brothers Mill Gap in the SE. cor. sec. 19, T. 12 S., R. 4 E.

The thickness of the Chattanooga shale in the Greasy Cove area is variable, but in most places is 35 feet or less. On one outcrop, in the northern half of the SW¼, sec. 35, T. 11 S., R. 4 E., the width across apparently vertical beds was 66 feet, but this thickness is probably due, in part, to duplication by faulting.

Carboniferous System

MISSISSIPPIAN SERIES

Fort Payne chert, Tuscumbia limestone, Ste. Genevieve limestone, and Gasper formation.—The Fort Payne chert, Tuscumbia limestone, Ste. Genevieve limestone, and Gasper formation are mapped as one pattern on the Greasy Cove geologic map (Pl. 2). These formations include the strata between the Chattanooga shale below and the Hartselle sandstone above. The first three formations definitely crop out in the area, and shale that has been seen in one place directly under the Hartselle sandstone is probably of the Gasper formation.

The Fort Payne chert is composed of cherty limestone beds with a small proportion of shale. The limestone weathers easily, supplying quantities of residual white to gray, crinoidal chert which usually occurs in beds of varying thickness up to a maximum of 4 to 5 inches. These beds of chert preserve the original stratification, but shatter easily, so that outcrops are covered with fragments of chert and decomposed, gritty, siliceous material. The shale of this formation is blue, dense, calcareous, and fossiliferous, and weathers easily.

There are practically no exposures of the limestone beds of the Fort Payne chert, but the stratified beds of characteristic chert

crop out in small valleys on the slopes of the Red Mountain ridges. Excellent exposures of chert usually can be seen in gaps of the ridge where, in many places, this material has been taken from small pits for road metal.

The Tuscumbia limestone is composed of gray, thick-bedded, fossiliferous limestone, with which may occur, in places, dark-blue, fine-grained, dense, fossiliferous limestone, but the last type is rare. Outcrops of this formation usually are masked by residual chert, and fresh limestone beds are seldom seen.

The Ste. Genevieve limestone is composed of limestone strata with a small quantity of interbedded shale. The limestone is in beds from 1 to 5 feet thick, gray to blue, dense to coarsely crystalline, and fossiliferous. Some beds are oolitic. Silicified fossils are sometimes found in the residual soil from this formation.

The Ste. Genevieve limestone apparently resists weathering more readily than the limestone of the Fort Payne and Tuscumbia formations, and outcrops of its limestone beds are common. There are many exposures along Little Canoe Creek, on the northwest side of Chandler Mountain, particularly in the NW¼ sec. 21, T. 12 S., R. 4 E., where a considerable thickness is found, and where the creek has eroded a small natural bridge in the limestone. Another good exposure is found at the northeast end of the main Chandler Mountain syncline, in the SW¼ sec. 13, T. 12 S., R. 4 E., and still another at the intersection of the Beeson Cove-Chandler Mountain roads in the NE¼SW¼ sec. 4, T. 13 S., R. 4 E.

Along the road which forms a part of the southwestern boundary of the area, in the NW¼ sec. 26, T. 13 S., R. 3 E., a dark gray to black, fossiliferous shale, thought to be of the Gasper formation, crops out. The shale lies directly under the Hartselle sandstone, and there seems to be a thickness of about 50 feet or less.

The total thickness of the strata between the Chattanooga shale and the Hartselle sandstone ranges between 250 and 300 feet.

Hartselle sandstone.—The Hartselle sandstone is composed of medium-grained, non-fossiliferous, friable to well-cemented sandstone in beds of varying thicknesses up to a maximum of 6

feet. In places the rock is cross-bedded. Weathered exposures show a predominantly gray color, but in detail may show zones and patches colored by brown iron oxide. The rock is soft enough to weather into beds of sand in places but in other places it is so hard that it forms a low ridge here and there in the valley between higher ridges capped by resistant sandstone of the Red Mountain formation on the one side and sandstone of the Pottsville formation on the other. Folding has converted the Hartselle sandstone into rocks which are essentially quartzites in several places.

Outcrops of the Hartselle sandstone are common in the valley mentioned above, and also on the southeast side of Chandler Mountain. The formation crops out in the center of the unsymmetrical area northeast of Shores Gap.

The Hartselle sandstone is about 200 feet thick.

Bangor limestone.—The Bangor limestone is composed of gray to dark blue gray, fossiliferous limestone. The bryozoan **Archimedes** is common, especially the spiral axial parts, and the frosd-like parts are not uncommon. Forms of the blastoid **Pentremites** and spiriferoid brachiopods are also found. The limestone crops out in places in shaly layers, but usually it is in beds from 1 to 4 feet thick. It is dense anl rarely may be crystalline or oolitic. Nodules of dark gray chert are occasionally found in the Bangor limestone. The chert often has a porous texture due to the presence of many molds of crinoid stems of small size. In one outcrop, this fossiliferous chert was found in well-defined layers.

Along the slopes of Chandler and Blount Mountains, the Bangor limestone is generally hidden by debris from formations which crop out higher up. One fairly complete section can be seen at the base of Chandler Mountain at the northeast end, and another in and near Hyatts Gap at the southwest end of the mountain.

The Bangor limestone is 450 to 500 feet thick.

Parkwood and Pennington formations (undivided).—On the slopes of Chandler and Blount Mountains a series of shale and sandstone beds above the Bangor limestone and below the Pottsville formation are thought to be mostly of the Parkwood forma-

tion, with a thin series of shale beds, the Pennington shale, at the bottom.[1] The Pennington shale is composed of interbedded red and tan shales which vary from place to place. The thickness of these shales is unknown, but it is probably only 25 feet or less. The red shales grade upward into a series of shales that are gray when fresh and tan when weathered. Near the bottom of the gray shale, fossiliferous beds occur. Within the shale are streaks, lenses, and thin beds of sandstone which are variable in number and thickness. Sandstone beds are generally present from 40 to 100 feet above the bottom of this shale. The sandstone is olive green, medium-grained, siliceous, and non-fossiliferous. It occurs in thin to thick massive layers.

The shale may be seen on the roads which go up Chandler and Blount Mountains, but the sections naturally are incomplete. One good exposure can be seen in the re-entrant valley of Gulf Creek on the southeast side of Chandler Mountain.

The total thickness of these formations is from 700 to 750 feet.

Pennsylvanian series

Pottsville formation.—The Pottsville formation is composed of sandstone, shale, and conglomerate. The sandstone beds are from 1 inch to more than 10 feet thick. They are medium to coarse-grained, siliceous, slabby, and resistant. The color ranges from white to brown, depending on the degree of weathering to which they have been subjected. Small well-rounded quartz pebbles are scattered through the sandstones in variable quantity. The shale is buff to tan, sandy, and is interbedded with the sandstone. The shale may occur in units up to 20 or more feet in thickness. Conglomerate beds of variable thickness and extent occur near the bottom of the formation and similar beds are also found higher up in the sandstones. The conglomerates are usually composed of coarse sand grains with numerous well-rounded small quartz pebbles.

The resistant sandstones form ridges, broad synclinal plateaus, and escarpments. Within the Greasy Cove area the sandstones cap Blount and Chandler Mountains. Massive tabular boulders

[1]Tentative.—Personal communication from James Steele Williams, United States Geological Survey.

40 to 50 feet long and 10 to 12 feet thick are found on the slopes of the mountains below outcrops of the Pottsville formation.

The Pottsville formation is at least 600 feet thick within the Greasy Cove area.

ECONOMIC GEOLOGY

The Red Iron Ores

A preliminary report[1] on the red iron ores of Greasy Cove and vicinity has been published. The paper includes a brief description of the geology, details of the ore beds, and a small-scale, generalized outcrop map of the red ore beds. Material for the report was gathered during several field seasons, culminating in 1930. The information presented below is derived in part from Burchard's paper, and in part from records obtained by Andrews since 1937.

The beds of red iron ore in the Greasy Cove area crop out with various attitudes in the foothill ridges formed by the resistant sandstone of the Red Mountain formation. Along the southeast side of Greasy Cove the beds generally dip moderately to the southeast, but on the northwest side they dip steeply northwest, and may be vertical or even overturned. On the southeast side of Chandler Mountain outcrops of red ore are rare in comparison to the number within Greasy Cove proper, but where seen, the beds usually dip steeply northwest. On Moragne Mountain the beds have moderate dips, but vary in direction of dip within short distances in relation to their position on the complex small synclinal fold.

The thickness of the red iron ore beds ranges from 1 inch or less to a maximum of 7½ feet, (See Figs. 3A and 3B) but the usual thicknes at most places is less than 2 feet. The 7½-foot thickness is exceptional and has been measured at only one place at the head of the Cove. It is presumably due to local thickening at the crest of the anticline. Here and there the beds are so thin that they cannot be traced, and their presence is indicated by scattered pieces on the surface. In some places the beds have been squeezed or faulted

[1] Burchard, Ernest F., op. cit.

Fig. 3A. Face of red iron ore bed 7½′ thick near head of Greasy Cove.

Fig. 3B. Open pit mining of red iron ore bed near head of Greasy Cove.

[illegible] in other places their disappearance seems to be due to [illegible]. Prospecting and mining in [illegible] Cove [illegible] simplified the tracing of outcrops. [illegible] are found southeast of Chandler Mountain.

The [illegible] vary from place to place in the same bed or [illegible]. They are [illegible] and [illegible] in varying proportions. Much [illegible] and in places it is firm and compact [illegible] in blocky pieces from 2 to 4 inches [illegible] fine-grained [illegible] and occasionally may be of the "flaxseed" type. In places flat ferruginous pebbles with diameters up to 3 or 4 inches and thicknesses up to 1 inch [illegible]. These pebbles are abundant in the mines north[illegible] (Pl. 2, localities [illegible] 11 and 12 and Figs. 4, 5A, and 5B.

Most of the ore is abundantly fossiliferous, but the fossils are largely fragmentary remains instead of complete specimens. Fossils collected by Burchard were identified by E. O. Ulrich and Charles Butts of the United States Geological Survey as follows:

Fossils identified by E. O. Ulrich:

Corals	Bryozoa
Favosites aff. F. niagarensis	Lioclemella ohioensis
Favosites aff. F. forbesi	Hallopora magnopora
Heliolites interstinctus	Rhinopora verrucosa
Halysites catenulatus microporus	Phaenopora fimbriata
Halysites catenulatus, large var.	Pachydictya bifurcata
[illegible]	Hemitrypa ulrichi
Ptychophyllum aff. P. ipomoea	Polypora aff. P. incepta
Diphyphyllum cf. D. multicaule	

Fossils identified by Charles Butts:

Corals

Halysites catenulatus microporus

Ptychophyllum ipomoea Foerste (not Davis)

Parts of crinoid stems are common in the ores, and rarely trilobite pygidia are found. Pieces of other unidentified fossils are also present.

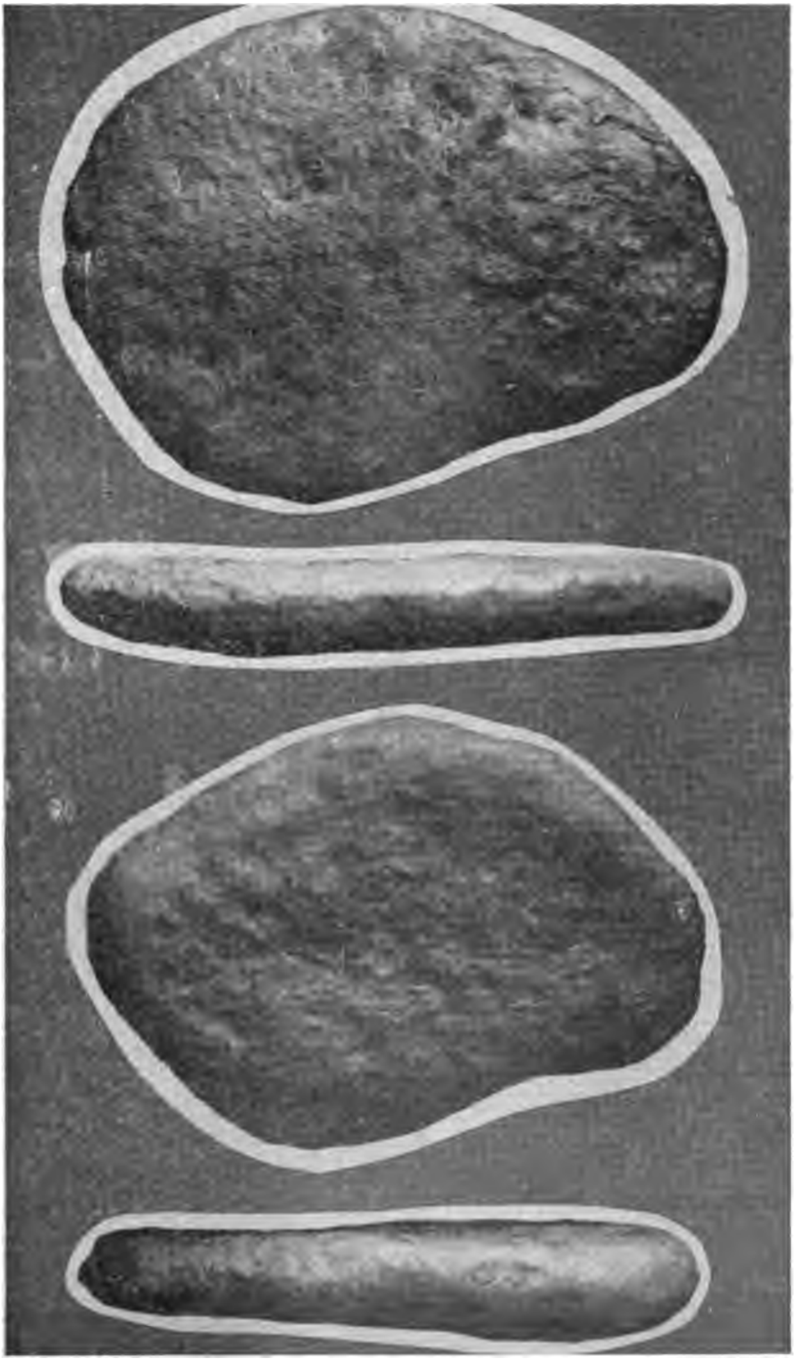

Fig. 4. Pebbles of red iron ore from Schoolhouse Gap showing flat sides and edges. (Natural size.)

Fig. 5A. Broken pebbles of red iron ore showing oolitic and flaxseed texture.

Fig. 5B. Pebbles of red iron ore lying horizontally in matrix of similar iron ore.

The unweathered hematite beds are essentially ferruginous limestones, relatively low in metallic iron, which contain minor amounts of silica, alumina, and phosphorus. Weathering mainly causes a loss of calcium carbonate, so that other constituents are proportionately increased in a given mass. The material high in calcium carbonate is known as "hard" ore, and the weathered material as "soft" ore. The soft ore extends to various depths below the surface, and is the only ore mined in the Greasy Cove area. Mining practically always ceases when the hard ore is reached.

Three beds of red iron ore crop out at the head of Greasy Cove. Each bed has characteristics by which it can be recognized with a fair degree of certainty. Correlation of the individual beds is possible for considerable distances, and tentative correlations may be carried further. The many prospects along the strike help to make recognition more positive.

The three beds beginning with the stratigraphically lowest one are known locally as the "low phos", the "sandy", and the "big coral" beds. Intervals between them vary, but in an exposure at Brothers Mill Gap the second is about 30 feet stratigraphically above the lowest, and the third about 40 feet above the second.

The apparently diagnostic feature of the "low phos" bed is an abundance of molds of segments of crinoid stems. The molds are about a quarter of an inch in diameter, and surround small low truncated conical projections representing material pushed up into the hollow center of the segment. Fresh bedding surfaces of this ore bed appear to be covered by small buttons with high centers. Similar fossils are found in other beds, but not in as persistent quantity as in the lower bed. This bed is usually 1 foot 4 inches or less in thickness, but in places reaches a thickness of 4 feet 6 inches.

The "sandy" bed is recognized by the abundant coarse quartz sand grains in the ore. The quartz grains are well rounded, and are about half the size of a pea. Some soft ore of this bed is compact enough to resist weathering, so that slabs of the ore accumulate on outcrops in places. The bed is lean and few attempts are made to exploit it commercially.

The "big coral" bed is characterized by abundant fossil remains. One of the most common is a coral **(Ptychophyllum)** which has a round base about 1 inch to 1½ inches in diameter. Other fossil corals have branches extending 1 foot to 1 foot 6 inches long. This bed in several places contains the flat ore pebbles referred to above.

From the head of the Cove, the "low phos" bed can be traced northeastward to the end of the southeast Red Mountain ridge, and can be correlated tentatively with the strip of the Red Mountain formation on the northwest side of the Cove. It apparently forms most of the outcrops of ore beds on the southeast side of the Chandler Mountain syncline, and is thought to be the one which should be correlated with the red ore bed in Moragne Mountain.

The "sandy" bed can be traced northeastward from the head of the Cove in the southeast Red Mountain ridge, but the outcrop swings around the northeast end of the Chandler Mountain syncline at Shores Gap and apparently lenses out 1 mile to the south of the Gap. The outcrop can be traced on the northwest side of the small syncline northeast of Shores Gap, but not on the southeast side. The "sandy" bed cannot be traced on the northwest Red Mountain ridge in Greasy Cove for more than three-quarters of a mile beyond McLendon Gap.

The "big coral" bed can be followed from the head of the Cove northeastward in the southeast ridge to a point just northeast of Garigues Gap where it thins out and disappears. In the northwest Red Mountain ridge this bed can be traced to a point about three-quarters of a mile beyond McLendon Gap. It was recognized in the old Tumlin Gap mining area, about a mile farther northeast. If the flat pebbles of iron ore are diagnostic of a definite bed in the series the "big coral" bed which alone contains these pebbles at the head of the cove should be correlated with the bed which crops out near Schoolhouse Gap.

Data on the three beds are given in the detailed descriptions below. The arrangement of facts is logical since the outcrops of the red ore beds in the Greasy Cove area fall into two natural subdivisions: those in the strip of Red Mountain formation on the

eastern border of Chandler Mountain, and on the northwest and southeast borders of Greasy Cove.

Whitney.—The Red Mountain formation on the southeast limb of the Chandler Mountain syncline and of the small synclinal basin northeast of Shores Gap crops out southeast, east, and northeast of Chandler Mountain. The strip of Red Mountain strata is not continuous here because the whole formation is cut out for short distances by faults in several places southeast of Chandler Mountain, but the outcrops, where present, usually lie less than 2 miles northwest of the Alabama Great Southern Railroad. The strip of Red Mountain formation farthest southwest begins at the boundary of the Greasy Cove general area on State Highway No. 38 at a point nine-tenths of a mile northwest of Whitney in the NW¼ sec. 26, T. 13 S., R. 3 E. It extends northeastward through section 24 and terminates against a fault in the SE¼ sec. 18, T. 13 S., R. 4 E. The strata in this strip are greatly disturbed and show considerable variation in strike and dip. In one place the beds are obviously repeated by faulting.

Between 1880 and 1890 some prospect pits were dug at the southwest end of this strip but were partly obscured at the time of McCalley's visit and were entirely obliterated when the present survey was undertaken. The following section, measured by McCalley at the mouth of one of the drifts, gives a fair representation of the ore seam and its inclosing rocks: (Plate 2, 1)[1]

Section of iron ore bed 1 mile northwest of Whitney, near center of NW¼ sec. 26 T. 13 S., R. 3 E.

(M. II, p. 278)

	Ft.	In.
Shale, dark		
Shale, ochreous, may carry a little ore		4
Ore	1	6
Shale, visible	6 to 8	

Total ore, 1 foot, 6 inches.

On the northeast side of the road in this same locality a bed of granular, argillaceous, fossiliferous soft red ore about 1 foot 2 inches thick is exposed in the bank. Red ore outcrops could not

[1]Plate numbers are followed by locality numbers. "M. II", signifies McCalley's "Valley Regions, vol. II".

be located in any other place in this strip, but in several places sparse red ore float was mixed with abundant sandstone debris.

Gulf Creek.—The next strip to the northeast, which is almost 3 miles long, begins in the NE¼ sec. 18, T. 13 S., R. 4 E., extends through sections 17, 8, and 9, and ends in the SE¼ sec. 4, T. 13 S., R. 4 E. Gulf Creek flows across an unsymmetrical anticline in the Red Mountain formation in a gap in the NW¼ NW¼ sec. 17, T. 13 S., R. 4 E. (Pl. 2, 2) Strata of the southeast limb dip about 70° S. 20° E., and on the northwest limb dip 30° N. 20° W. On the northeast side of the creek a seam of ore and shale apparently about 1 foot 2 inches thick appears at the southeast base of the hill at the side of an old woods road. A section measured by McCalley on the southwest side of the gap is as follows:

Partial section of Red Mountain formation on southwest side of Gulf Creek in the NE¼ NE¼ sec. 18, T. 13 S., R. 4 E.
(M. II, p. 279)

	Ft.	In.
Devonian, black shale		
Red Mountain formation.		
Debris	4-5	
Sandstone, about	20	
Shale, hard and yellowish, with streaks of ore, about	15	
Ore, mixed with shale	1	1
Ore, badly weathered, soft or loose like sandy loam	3	6
Shale, visible	10-15	

Dip 60° to 85° SE. Total shaly, sandy ore 4 feet, 7 inches.

Northeast of Gulf Creek strata of the Red Mountain formation have various dips but the strike is generally northeast. Along the Beeson Cove road near the end of this strip an exposure almost at right angles to the strike of the strata shows that the beds are closely folded and faulted. Ferruginous sandstone and shale were seen in the section along the road, but no ore seams. Sparse float from ore beds was noted elsewhere in the strip, but no other outcrops than those given above.

An outcrop of the Red Mountain formation parallel to this strip and lying mostly in the SE¼ sec. 8, T. 13 S., R. 4 E., is exposed in a fenster about a half a mile long. Float from sandy ore beds was seen in the fenster area, but no ore seams in place were noted.

The next strip of Red Mountain formation is about half a mile long. It begins in the NW¼ NW¼ sec. 3, T. 13 S., R. 4 E., and ends in the SW¼ SE¼ sec. 34, T. 12 S., R. 4 E. No red ore in place or as float was noted in the strip.

Steele.—Another strip of Red Mountain formation paralleling the Alabama Great Southern Railroad begins against a fault a quarter of a mile northwest of Steele in the SE¼ sec. 34, T. 12 S., R. 4 E., and extends without break to its end in the northwest part of sec. 4 T. 12 S., R. 5 E. Between Steele and the gap of Little Canoe Creek—the boundary between St. Clair and Etowah Counties—about 2½ miles northeast, the Red Mountain strata have vertical or steep northwest dips. Several old prospect pits along the strike of a firm, sandy, lean ore bed about 1 foot thick were noted by Andrews in the SE¼ SE¼ sec. 34, T. 12 S., R. 4 E. This bed is probably the lower seam of two reported in this vicinity by McCalley. A section by McCalley (M. II, p. 280) of the upper iron ore seam is as follows:

Section of iron ore bed northwest of Steele in SE¼ sec. 34, T. 12 S., R. 4 E.
(Pl. 2, 3)

	Ft.	In.
Shale		
Ore, soft, low specific gravity	1	3
	to	
	1	4
Shale, yellow		6
Ore, soft, low specific gravity about	2	6

Dip about 75° NW. Total ore, about 3 feet, 9 inches.

Partial analyses of the soft ore from the two seams are reported by McCalley (M. II, p. 280) as follows:

Analyses of soft iron ore from near Steele

Fe	SiO_2	P
45.18	26.23	0.235
57.78	9.62	0.123

No other outcrops of ore were seen in this strip southwest of Little Canoe Creek, and little float ore could be found.

Northeast of Little Canoe Creek the outcrop of the Red Mountain formation in the main northwest ridge in sec. 24, T. 12 S., R.

4 E. is repeated on the southeast in a lower ridge about 1 mile long which terminates against faults in the NE¼ sec. 24. The strata in the southeastern ridge are overturned and dip steeply southeast. No outcrops or float of red ore were noted.

In a wash in a small valley at the southwest end of the main ridge northeast of Little Canoe Creek a bed of lean ore 4 to 6 inches thick was noted but no other outcrop or conspicuous float of red ore was seen for a mile to the northeast.

Southwest of Attalla.—The Red Mountain formation has a wide outcrop along the crest of the transverse fold which separates the upper strata of the Red Mountain and strata of higher and younger formations of the Chandler Mountain syncline from those in the smaller syncline between Shores Gap and Attalla. On a high hill in the NE¼ SE¼ sec 13, T. 12 S., R. 4 E., red ore float of the "low phos" and "sandy" beds was noted. The "sandy" bed can be traced by float and by a few old prospect trenches around the small valley at the northeast end of the Chandler Mountain syncline and to the north until the outcrop of the ore bed becomes a part of the outcrop of the Red Mountain formation on the ridge along the southeast side of Greasy Cove. No outcrops were seen where a measurement of the bed could be made. In the SE¼ SE¼ sec. 12, T. 12 S., R. 4 E., and at the common corner of secs. 12 and 13, T. 12 S., R. 4 E., and secs. 7 and 18, T. 12 S., R. 5 E., two outliers of the "sandy" bed crop out around two hills. (Pl. 2, 4) Quantities of float ore are scattered over the surface, and several tons have been piled up. The ore is firm, slabby, granular, and full of coarse quartz sand grains.

Erosion has not gone deep enough into the Red Mountain formation to separate the outcrop of the "low phos" bed southwest and northeast of Shores Gap. This bed can be traced by float and by numerous old prospect trenches around a small re-entrant valley to the south of Shores Gap and for about half a mile to the northeast, or to the NE¼ NE¼ sec. 18, T. 12 S., R. 5 E. The bed is obviously lean and thin.

For the next mile northeastward no red ore was noted. In the NE¼ SE¼ sec. 8, T. 12 S., R. 5 E., near Gaines Chapel, a local road crosses the strip of the Red Mountain formation, and on the northeast side of the road, in the end of a low ridge, the

strata of the formation are exposed in a small unsymmetrical anticline. The strike of the fold and ridge is about N. 60° E., but in less than a quarter of a mile the trend of the ridge changes to about N. 20° E. Red ore float of the "low phos" bed was noted along the top of the ridge. In the side of a small valley two small old trenches showed two outcrops, apparently of the same bed, 10 or 12 feet apart, a repetition due either to close folding or faulting. (Pl. 2, 5) Float ore of the "low phos" bed was found along the ridge for 1 mile northeastward to the end of the synclinal basin about 2 miles west of Attalla. No recognizable float of the "sandy" bed of the Greasy Cove section was found in this vicinity. In 1916 the following section was noted on this ridge:[1]

Section of iron ore bed in W½ SW¼ sec. 4, T. 12 S., R. 5 E., about 2¼ miles west-southwest of Attalla

	Ft.	In.
Shale		
Ore		6
Shale		8½
Ore	1	
Shale		

Bed is vertical. Total ore 1 foot, 6 inches.

At the end of the strip in the northwest part of sec. 4, T. 12 S., R. 5 E., the rocks are greatly disturbed and the strata at the end of the southeast limb of the small syncline have been thrust over the strata at the end of the northwest limb for several hundred feet. A number of old prospect trenches and pits are found in this vicinity and all appear to be on the same bed, which has been repeated by faulting. An outcrop of the "low phos" bed about 1 foot 6 inches thick was noted in a shallow trench on the steep southeast slope of the ridge. (Pl. 2, 6). The ore is soft, oolitic, and crinoidal, and contains many small corals. Other outcrops of the ore bed in this vicinity measured at two places about 50 feet apart showed the following sections:

[1]Report by Prof. Wilbur A. Nelson to owners of property.

Sections of iron ore bed near small branch of Big Wills Creek 2 miles west of Attalla

1.

	Ft.	In.
Shale		
Shale with a few ferruginous streaks		10
Ore, hematite, with scale of limonite at top	1	10
Shale		

Beds dip steeply almost west. Total ore about 1 foot.

2.

	Ft.	In.
Shale		
Shale with a few ferruginous streaks		10
Ore, hematite, with scale of limonite at top	1	3½
Shale		

Beds dip steeply almost west. Total ore about 1 foot, 3½ inches.

The following section of the ore bed in this vicinity was made by J. R. Ryan:

Section of iron ore bed near branch of Big Wills Creek 2 miles west of Attalla

	In.
Shale	6
Ore, soft, good	1½
Ore, good	3
Shale	½
Ore, good	9
Shale	

The bed is vertical. Total ore, 1 foot, 1½ inches.

A section by McCalley in this locality is as follows:

Section of iron ore bed at northeast base of ridge in NE¼ NW¼ sec. 4, T. 12 S., R. 5 E.

(M. II, p. 206)

	Ft.	In.
Sandstone, yellow shaly		
Ore, red		4
Shale, yellowish gray		4
Ore, red	1	4
Sandstone, hard		

Dip about 85° W. Total ore 1 foot, 8 inches.

McCalley states that the best outcrops of red ore southeast of Chandler Mountain are about 2 feet thick, but this thickness must be rare. It is obvious from the records presented here that there is not much red ore of commercial importance in outcrops of the Red Mountain formation southeast, east, and northeast of Chandler Mountain, and that in most places mining would be difficult because of the disturbed condition of the strata.

Additional data on the iron ore beds in the vicinity of Shores Gap and along the northwest limb of the synclinal basin west of Attalla are given farther along in the text, pages 94-96 and 104-112.

The Cove.—The Red Mountain formation crops out in the foothill ridge bordering Greasy Cove in a V-shaped strip which terminates on the southwest in the NW¼ sec. 36, T. 12 S., R. 3 E. The two prongs extend northeastward from this point, the one on the northwest side ending in the NW¼ NW¼ sec. 36, T. 11 S., R. 4 E., and the one on the southeast side ending in the SW¼ sec. 33, T. 11 S., R. 5 E. The outcrops are separated from those farther northeast in Wills Valley by faulted areas in which no Red Mountain formation appears.

Burchard described many sections of iron ore beds of the Red Mountain formation in Greasy Cove in his preliminary report[1] published in 1933, but the supply of copies of this paper has become nearly exhausted. Much of the material of the earlier publication is therefore included in the present report, and the same order of arrangement of the material is followed. The data are given beginning at the northeast end of the strip of Red Mountain formation on the northwest side, extending southwestward to the head of the Cove, and thence northeastward to a point about 2½ miles west of Attalla.

Northwest border of the Cove

West of Ivalee:—The strip of Red Mountain formation on the northwest side of Greasy Cove begins in the NW¼ NW¼ sec. 36, T. 11 S., R. 4 E., about 1½ miles west of the station of Ivalee on the Louisville and Nashville Railroad. Northeast of this point to the border of the Greasy Cove map area at a gap near Littleton,

[1]Burchard, Ernest F., op. cit.

a distance of about 3 miles, the Red Mountain formation is faulted below the surface. A careful search failed to reveal any float ore or ore in place throughout the entire distance despite rumors to the contrary.

The first outcrops of ore beds on the northwest side appear in a wash on an old road near the end of the strip. (Pl. 2, 7) The section is as follows:

Section of iron ore bed on old road in NE¼ NE¼ sec. 35, T. 11 S., R. 4 E.

	Ft.	In.
Ore, sandy, shaly		4
Sandstone	1	
Clay, ferruginous		2-3
Ore, fossiliferous		10

Dip about 35° N. 10° W. Total ore about 1 foot, 2 inches.

About 300 feet farther north on this same road a bed of lean ore 6 inches thick, dipping 32° S. 45° W. was seen in a ditch on the side of the road. No float ore from the bed could be found nearby.

Southwestward from the above locality for about four-fifths of a mile the outcrop of red ore beds is traced by many old pits and trenches on the southeast slope of a low ridge. The ore beds range in thickness, from 6 inches to 1 foot, 6 inches and in dip from 40° southeast to 85° northwest, with the beds vertical in places. The presence in some places of two beds of ore about 6 feet apart is indicated by the parallel arrangement of the test holes.

The ore is fossiliferous, granular, and firm, and it breaks out in pieces from 1 to 3 inches thick. Crinoid stems and a few small corals are present. Much of the ore is slickensided. Samples of the ore which were soft, and contained no lime, showed 43 to 49 percent of iron, 11 to 16 percent of silica, 6 to 10 percent of alumina, and 8 to 14 percent of water.

There is a well-exposed section of the Red Mountain formation in the NE cor. NW¼ SW¼ sec. 35, T. 11 S., R. 4 E., where a local road crosses the ridge in a gap. (Pl. 2, 8) The beds are mostly sandy shale and thin sandstone dipping 81° northwest, and measuring nearly 450 feet in total thickness. (Cf., p. 39.) On

the northeast side of the road two ferruginous seams showing respective thicknesses of 1 foot, 9 inches, and 10 inches, separated by 6½ feet of sandstone and shale were noted.

The ore is fine-grained, firm, and fossiliferous. Crinoid remains are common, but the seams do not contain the large fossil corals nor the flat ferruginous pebbles which characterize the "big coral" bed to the southwest near the head of the Cove. The two thin beds in the gap mentioned above cannot be correlated definitely with the more easily recognizable beds farther southwest.

On the southwest side of the gap a sample of ore was taken during a private survey, the records of which indicate a thickness of 1 foot 10 inches, with constituents averaging about as follows: Iron, 36.5 percent; silica, 25 percent; alumina, 9 percent; lime, 0.8 percent; phosphorus, 0.45 percent; manganese, 0.7 percent; and water, 15.6 percent. The ore dips 85° northwest.

Schoolhouse Gap.—Schoolhouse Gap, in the NE¼ NW¼ sec. 3, T. 12 S., R. 4 E., is 1.1 miles southwest of the gap just mentioned. Outcrops of ore are found along the ridge between the two gaps, but the thick ore bed which has been worked at Schoolhouse Gap cannot be correlated with either of the two thin beds in the gap to the northeast.

The bed at Schoolhouse Gap is composed of fossiliferous soft red ore containing fragments of crinoids, brachiopods, and small single corals. The bed contains a number of flat ferruginous pebbles which range in diameter from ½ to 6 inches and in thickness from one-eighth to three-quarters of an inch. These pebbles, which are of material almost identical with the ore bed itself, occur near the bottom of the ore bed. Similar pebbles are found in the "big coral bed" at the head of the Cove, but no large fossil corals characteristic of the "big coral" bed were found in the ores at Schoolhouse Gap. These pebbles of iron ore are described in greater detail on pages 96-97 of this chapter. (See Figs. 4 and 5, pages 47, 48.)

Two tunnels, a shaft, and many trenches and test pits were made on the ore bed which ranges in thickness from about 4 feet to 6 feet 5 inches. Most of the openings are within half a mile northeast of Schoolhouse Gap. The greatest part of the mining in this vicinity was done many years ago, and in 1938 the old mine openings were caved in many places.

The northeastern, or No. 2 tunnel, was driven N. 65° W. into the ridge from the southeast side about 125 feet to the ore which dips 60° to 70° northwest. Levels were opened to the right and left on the ore bed. In this tunnel about 20 feet from the ore bed the rock is much disturbed and fragments of ore are mixed with shale, indicating a fault plane along which some of the ore bed has been dragged, and at the intersection of the tunnel and the left level the ore has been overturned and apparently pinched out. Near the face of the right level the ore bed was sampled in eight 6-inch portions, the averages of the analyses of which were as follows: Iron, 25.6 percent; silica, 36 percent; alumina, 12.5 percent; lime, 1.5 percent; phosphorus, 0.4 percent; manganese, 0.13 percent; water, 12 percent. The bed here dipped 70° northwest.

The southwestern or No. 1 tunnel, is 800 to 1,000 feet southwest of tunnel 2, and reached the ore at 150 feet from the entrance and 80 feet below its outcrop on the crest of the ridge. The ore bed has a thickness of about 4 feet and dips 83° northwest. The ore is fossiliferous, more or less slickensided, and contains many flat pebbles of ore and of a very fine grained ferruginous sandstone having a calcareous cement, which are reported to occur near the bottom of the bed. Analyses of the ore from the right and left levels showed approximate averages respectively as follows: Iron, 41.5 and 42 percent; silica, 19 and 18.5 percent; alumina 8 and 7 percent; lime 1.8 and 2.5 percent; phosphorous, 0.64 and 0.70 percent; manganese, 0.15 and 0.15 percent; water, 13 and 15 percent.

The ore bed at some depth in this vicinity should dip moderately and evenly toward the northwest and pass beneath Blount Mountain. In order to test this inference a hole was drilled in the NW¼ SW¼ SE¼ sec. 34, T. 11 S., R. 4 E., (Pl. 2, 10)[1] north of the shaft mentioned below. The hole, which was drilled at an angle of 60° southeast, first passed through 250 feet of loose material, which had to be cased, then through limestone to a depth of 1500 feet.

No rocks or iron ore of the Red Mountain formation were encountered. It seems to have been drilled deeply enough to encounter the ore in the overturned strata, or else the ore bed may have been cut off at considerable depth by a fault.

[1]Personal communications in 1930 and in 1945 from M. O'Toole, drilling contractor, Birmingham, Alabama.

A prospect shaft (Pl. 2, 9) 1200 feet northeast of Schoolhouse Gap is just east of the crest of the ridge at an elevation of 910 feet. It follows a nearly vertical bed of ore that strikes N. 35° to 40° E. and is about 6 feet 5 inches thick including partings. When visited in 1928, 1938, and 1941 the shaft could not be entered to obtain detailed measurements, but shaly and sandy seams in the bed would reduce the total thickness of ore. The shaft reached hard ore, and some specimens show much calcium carbonate.

The Schoolhouse Gap shaft was sunk at considerable expense by some Chicago business men shortly after the first World War, and each foot of the cross section of the ore bed was carefully sampled at several depths. A summary of the results of sampling and analyses at certain of these depths within the hard ore is as follows:

Data concerning vertical iron ore bed in shaft north of Schoolhouse Gap[1]

Depth (feet)	Thickness of bed	Fe (percent)	SiO_2 (percent)	Al_2O_3 (percent)	CaO (percent)	P (percent)
70	8 feet. 9 in. (1 in. shale parting)	25.80	25.45	8.90	10.25	0.45
85	5 ft. 6 in.	32.30	17.80	7.02	11.00	.48
			Insoluble			
93	8 ft. 4 in.	(17.60 to (35.40 (26.69 av.	14.10 to 39.80 28.94 av.		9.51 to 19.93 13.00 av.	
114	7 ft. 6 in.	(20.90 to (38.70 (28.45 av.	15.60 to 39.30 26.98 av.		10.23 to 17.80 13.00 av.	
126	7 ft. 2 in.	(23.80 to (35.70 (31.18 av.	13.70 to 35.60 23.64 av.		10.14 to 17.30 13.16 av.	
140	7 ft. 4 in.	(22.10 to (40.40 (29.91 av.	12.90 to 43.00 27.38 av.		8.60 to 15.20 11.94 av.	
150	6 ft.	(21.10 to (36.50 (30.82 av.	9.60 to 41.90 25.54 av.		7.20 to 18.90 12.33 av.	

[1]Courtesy of David Hancock, Birmingham, Alabama.

The detailed analyses show variations between every foot of the bed and no definite regularity in the quality of the ore according to its stratigraphic position, except that in general the lower part of the bed is of better quality than the upper part. The averages of the analyses show that the hard ore is below present-day commercial grade.

In addition to the deep shaft two test pits were dug nearby. A section in one of them and analyses of the soft ore from both pits are given below.

Section of iron ore bed at bottom of north test pit near Schoolhouse Gap shaft

	Ft.	In.
Clay		
Ore		4
Clay		2
Ore		2
Clay		1
Ore		5
Clay	1	3
Ore	1	7
Clay		1
Ore	1	9
Clay		
Total ore 4 ft. 3 in.		

Analyses of soft iron ore from test pits near Schoolhouse Gap shaft

(David Hancock, analyst, Birmingham, Alabama)

	Fe	SiO_2	Al_2O_3	P
North pit, 4 ft. 3 in. of ore	52.10	12.77	5.49	0.34
South pit, 5 ft. of ore	43.90	19.65	8.40	0.36
South pit, 3 ft. 6 in. of ore in lower pit	49.40	15.35	6.58	0.35

The soft ore, as would be naturally expected, contains sufficient iron to be of value, but the alumina is undesirably high.

The following section of an ore bed was made in 1938 in a new prospect opening at the head of a small valley (Pl. 2, 11) about 2,000 feet northeast of Schoolhouse Gap. The ore is soft, fossiliferous and limonitic.

Section of ore bed in small valley in the SE. cor. SW¼ SE¼ sec. 34, T. 11 S., R. 4 E.

	Ft.	In.
Shale		7½
Ore		5-6
Clay		1
Ore		1
Clay		½
Ore		½
Clay		½
Ore		3
Clay		½
Ore		1
Clay		1
Ore		1½
Clay		½
Ore		2½
Clay		1
Ore		1½
Clay		2
Ore	1	½
Clay		½
Ore	1	2½
Shale.		

Dip 66° N. 50° W. Total ore 3 feet 7 inches.

Another section was measured in 1938 in a new prospect (Pl. 2, 12) at the head of a small valley 1,000 feet northeast of the gap. The ore is fossiliferous and limonitic.

Section of iron ore bed in a small valley in NW cor. NE¼ sec. 3, T. 12 S., R. 4 E.

	Ft.	In.
Shale		
Ore		9
Clay		9
Ore		2¼
Clay		2¼
Ore		10½
Clay		10
Ore		4
Clay		1
Ore		2
Clay		½
Ore		5
Clay		2
Ore		2
Clay		1
Ore		4
Clay		½
Ore		2
Clay		1
Ore		2
Clay		1
Ore		2
Clay		1
Ore		2
Clay		2
Ore		10
Clay		4
Ore		10
Shale		

Dip 60° N. 50° W. Total ore about 5 feet, 7 inches.

At the northeast side of Schoolhouse Gap the ore bed crops out in an almost vertical position in a small hollow extending northeastward to the top of the hill. A drift and trenches were made on the ore bed, but the workings were all old and little could be seen. Pieces of good ore 2 to 3 inches thick were noted on the dump. At the southwest side of the gap a drift 30 feet long was filled with water when visited in 1938 and earlier.

From Schoolhouse Gap 1.2 miles to the gap in which the Louisville and Nashville Railroad crosses the strip of the Red Mountain formation in the NE¼ SW¼ sec. 4 T. 12 S., R. 4 E., ore beds crop out from place to place on the ridge, and here and

there are a few old prospect openings. The ore bed, which shows in the drift on the southwest side of Schoolhouse Gap can be traced along the southeast slope of the ridge for about seven-tenths of a mile. About half a mile southwest of the gap two small pits showing a much weathered red ore, dipping steeply northwest and associated with shale, were noted by Burchard. Much of the seam is shaly, but there are streaks of good, fine-grained "flax-seed" ore containing specks of limonite. The southwest pit shows about 2 feet 6 inches of ore merging into shaly ferruginous material above; the northeast of the two pits shows the following section:

Section of iron ore bed in test pit half a mile southwest of Schoolhouse Gap

	Ft.	In.
Shale, yellow		
Shale, purplish, with streaks and nodules of ore		8
Ore	1	10
Shale		

Dip 65° - 70° N. 30° W. Ore not more than 2 feet.

Near a small valley on the southeast side of the ridge in the SW cor. SE¼ NE¼ sec. 4, T. 12 S., R. 4 E., ore beds are displayed in several test pits, and from them a good idea of the disturbed condition of the strata can be gained. (Pl. 2, 13) Thirty feet below the crest of the saddle a bed of shaly soft ore 2 feet to 2 feet 6 inches thick containing flat ore pebbles, dips about 10° north. Within 100 feet northeast the bed dips about 80° S. 30° E. In the saddle above the test pits shale and sandstone beds dip 23° S. 40° E. On the northwest slope of the ridge 1100 feet northeast a bed of ore about 1 foot thick in a test pit dips about 30° northwest. Eight hundred feet southwest of the valley mentioned above test pits, with a little ore on the dumps, are found on both sides of the ridge near the crest, but no ore was noted on or near the crest farther southwest. Almost directly south of the last mentioned test pits a pit showing ore was found near the bottom of the slope, and other small prospects appear on this bed southwestward to the valley of the small creek which flows under the railroad almost directly across the strike of the beds. Near the point where the railroad crosses the outcrop of the Red Mountain formation the following section is exposed in a small prospect pit about 50 feet north of the railroad:

Section of iron ore bed in the NW¼ SE¼ sec. 4, T. 12 S., R. 4 E.

	Inches
Shale	
Ore, soft, argillaceous, fossiliferous	4
Shale with ore lenses	8
Ore, soft, fossiliferous	3
Ore mixed with clay	3
Ore, soft, fossiliferous	3

Dip about 75° N. 25° W. Total ore about 1 foot.

About 100 feet north of the above pit a shallow prospect trench more than 75 feet long is cut across the strata which strike here about N. 65° E. No ore beds are visible in the walls of the trench.

The thickness of overburden, the complexity of the close folding and faulting, and the sparseness of prospect openings makes it practically impossible to correlate these thin beds with those to the northeast. The presence here and there of flat ore pebbles in the beds indicates that the same ore bed exposed at Schoolhouse Gap extends some distance to the southwest but is greatly reduced in thickness.

No outcrops of ore beds were noted in the railroad cut. McCalley gives the following section of an ore bed in a gap near the point where the railroad crosses the Red Mountain formation.

Section of iron ore bed in NE¼ SW¼ sec. 4, T. 12 S., R. 4 E.
(M. II, p. 207)

	Ft.	In.
Debris		
Ore		5
Shale		8-10
Ore, good		2
Shale	1	
Ore, good		6

Dip 20° - 60° northwest. Total ore, 1 foot, 1 inch.

Gilliland Spring Branch.—About 500 feet southwest of the point where the Louisville and Nashville Railroad crosses the Red Mountain formation a test pit (Pl. 2, 14) on the east slope of a

small hill shows a bed of ore 1 foot, 6 inches thick dipping 53° southeast. An analysis of the soft ore showed the following average composition: Iron, 41.5 percent; silica, 21 percent, alumina, 11 percent; water, 10 percent. No lime was present in the samples analyzed. No other outcrops were noted on this hill, nor in the fields through which the outcrop passes, for over half a mile southwest of the railroad.

In the SE¼ SE¼ sec. 5, T. 12 S., R. 4 E., red shale and thin sandstone beds of the Red Mountain formation are displayed along the road south of Gilliland Gap (Pl. 2, 15). Two thin beds of ore, 2 inches and 4 inches thick, respectively, were noted in the road cut. From this road southwestward for about eight-tenths of a mile Andrews in 1937 found many openings but all were badly caved and little ore could be seen.

Examination of outcrops in this vicinity at an earlier date yielded records of ore at several of the openings. Southwest of the road and up the slope of the ridge several prospects showed no ore, but at the top of the ridge a prospect showed a trace of ore. A prospect slope (Pl. 2, 16) about 30 feet deep was sunk 600 feet southwest of Gilliland Gap on the dip of the ore which is 71° southeast. The ore was found to be about 2 feet, 3 inches thick, very firm, and of a fair grade with the exception of high alumina. An average of the analyses of five 6-inch sections showed 47 percent of iron, 15 percent of silica, 8.8 percent of alumina, 0.22 percent of lime, 0.33 percent of phosporus, 0.12 percent manganese, and 10 percent of water.

About 200 feet southwest of the prospect slope a drift northwest into the east side of the ridge intersected two ferruginous beds respectively about 115 and 150 feet from the entrance. The ferruginous beds are 5 to 7 feet thick but of very poor quality, containing only 6.5 to 15 percent of iron, with 45 to 56 percent of silica, 22 to 26 percent of alumina, and 14 to 16 percent of water. The beds have been badly disturbed by folding and faulting, and the ferruginous beds, if they represent the normal ore zone, have been greatly altered, or else were originally of poor grade.

About 1,450 feet southwest of Gilliland Gap a test pit in a hollow on the east side of the ridge is reported to show 2 feet 6 inches of ore dipping 76° northwest. The average of five samples

taken across this ore seam is reported to show 24 percent of iron, 41 percent of silica, 13 percent of alumina 0.05 percent of lime, and 10 percent of water. Two more prospects, a well and a trench, within a few hundred feet farther southwest, show ore about 2 feet 10 inches thick in the well and only a few inches thick at the trench; both seams stand nearly vertical.

Almost all of the above mentioned prospects are in the NW¼ NE¼ and NE¼ NW¼ sec. 8, T. 12 S., R. 4 E. Between the prospects and the road from Gallant and Tumlin Gap to Altoona, about half a mile to the southwest several test pits were dug but no ore was found. The ore outcrop in this vicinity has apparently been cut out by a fault to the point about 300 feet southwest of the highway where, on the crest of the ridge, begins the group of workings collectively known as the Tumlin Gap mine.

Tumlin Gap.—The mines near Tumlin Gap were visited in 1913, 1917, and 1928, but in 1928 the mine had long been idle and the workings could not be entered. When seen by Andrews in 1937 soft ore was being mined from one slope but operations soon ceased, and visits between 1937 and 1941 showed that work had not been resumed. In 1937, with the exception of the one slope, all of the openings were caved, and the trenches were filled with debris. Little ore in place could be seen.

Most of the openings near Tumlin Gap are in the S½ sec. 7, T. 12 S., R. 4 E. One entry is driven into the ridge from the northwest side in a small valley in the SE cor. NE¼ SW¼ sec. 7 and a slope farther southwest is driven down the ore bed from the outcrop on the southeast side of the ridge. Entries were driven along the strike of the ore to the right and left from these two openings. Near the southwest end of the workings is a shaft also, and another slope.

The following section was measured in a level in the northeastern part of the workings:

Section of iron ore bed in drift of Tumlin Gap mines

	Ft.	In.
Shale		
Shale, sandy, limonitic		3
Ferruginous sandstone, or "jack" rock		4-6
Ore		5-6
Shale		1-2
Ore	2	6
Shale		

Dip 83° N. 35° W. Total ore about 3 feet.

It was reported in 1917 that the level at the mine was 500 feet long and that the ore bed averaged about 2 feet 4 inches in thickness. The drift was driven practically on the top of the hard ore, and the soft ore was removed by overhead stoping. The soft ore examined was fine-grained, compact, and well-leached. It contained none of the large fossil corals indicative of the "big coral" bed. It was reported also that within the slope the ore in places showed a thickness of 4 feet 5 inches, but in other places thinned out considerably.

In 1937 a slope in the NW¼ SE¼ sec. 7, T. 12 S., R. 4 E., at the northeast end of this group of workings (Pl. 2, 17) had reached a depth of 96 feet. The ore removed was soft, fossiliferous, and limonitic. Before the end of 1938 the slope had reached hard ore at a depth of about 200 feet, and was abandoned. The following section of the ore bed was measured by Andrews at the mouth of the slope:

Section of iron ore bed in the NW¼ SE¼ sec. 7, T. 12 S., R. 4 E.

	Inches
Shale	
Ore	8½
Clay	1
Ore	8½
Clay	2½
Ore	2
Clay	1
Ore	1
Clay	3
Ore	8
Shale	

Dip 46° N. 40° W. Total ore 2 feet 4 inches.

About 1,000 feet southwest of the above mentioned slope the following section of an ore bed was measured in one of the old trenches:

Section of iron ore bed in old trench near southwest end of Tumlin Gap mine workings

	Inches
Ore	11
Clay	1½
Ore	2½
Clay	1
Ore	1
Clay	1½
Ore	3½
Clay	1½
Ore	4
Clay	2
Ore	8
Clay	½
Ore	7
Shale	

Dip 45° N. 37° W. Total ore, 3 feet 1 inch.

Analyses of iron ore samples from several places at the mines near Tumlin Gap were as follows:

Analyses of iron ore from near Tumlin Gap mines

Description	Authority[1]	Fe	SiO_2	Al_2O_3	CaO	P	Mn	H_2O
Semihard ore	GS	39.15	29.86[2]		....	....	0.54	....
Stope, 2 ft. 4 in.	GS	40.90	19.60	9.72	0.22	.47	.12	13.4
Outcrop, 4 ft. 2 in.	GS	55.16	6.94	4.28	None	.21	.08	16.1
Drift, av. 4 ft.	GS	47.50	12.30	8.64	None	.44	.33	18.1
Pile of ore	P	49.39	5.60	4.31	7.15	....	....	....
Ore, 2 to 3 ft.	P	53.72	6.80	5.02	2.26	....	....	....

[1]Gulf States Steel Co., dry basis; P, Wm. B. Phillips.
[2]Insoluble.

The following analyses made at different places down the slope show a similar composition for the ore:

Analyses of iron ore from near Tumlin Gap mines—a

Distance down slope (feet)	Thickness		Part of bed			Fe	SiO_2	Al_2O_3	CaO	P	Mn
	Ft.	In.		Ft.	In.						
30	4	5				48.60	13.75	5.92	....	0.45	0.17
			(Top	1		42.50	19.20	6.35	....	.59)	
			(2nd	1		51.00	10.20	5.14	....	.52)	
35	4	4	(3d	1		48.20	12.13	6.16	....	.51)	0.20
			(Bot.	1	8	49.60	12.00	5.10	....	.45)	
			(Top	1		47.30	10.65	5.39	1.60	.69	
			(2d	1		52.30	9.25	4.81	1.20	.58	
100	b—4	1	(Bot.	1	8	47.50	12.05	5.72	1.80	.67	
			(Computed (Average			48.85	10.92	5.39	1.58	.65	
120	c—3					35.70	9.30	5.87	12.05	.49	
			(Top		10	37.75	8.25	5.60	11.70	.78	.14
141	4		(Mid.	2		42.30	7.25	4.35	9.90	.51	.12
			(Bot.	1	2	24.00	27.25	10.82	6.30	.48	.16
181	2	6	All			37.90	4.70	3.63	13.45	.50	(d)
186						(39.60	5.60	4.31	13.40	.62	
(below	2	6	All								
"knuckle")						(39.40	5.90	4.97	10.45	.62	
190	2	9	All			40.70	5.40	4.64	8.65	.65	
210	2		All			34.70	10.10	6.37	8.15	.52	

a—Analyses by David Hancock, Birmingham.
b—Top 5 inches left as roof not sampled.
c—Top 1 foot or more left as roof not sampled.
d—Organic matter, 9.58 percent; also present in many other samples.

The trace of the ore bed is offset about 300 feet to the northwest in the SE¼ SW¼ sec. 7, T. 12 S., R. 4 E. (Pl. 2, 18) The ore bed, which appears in a few old prospects and drifts nearby in the NW¼ NW¼ sec. 18, T. 12 S., R. 4 E. is inferior to the bed at the Tumlin Gap mine, and where seen consists of ferruginous sandstone interbedded with thin beds of porous, limonitic, fossiliferous ore. The better streaks of ore resemble closely the ore at Tumlin and Schoolhouse Gaps, and although this bed may be a different one, it may be also the deteriorated southwestward extension of the same bed. It is entirely possible that the bed in this vicinity is continuous with the ore bed at Tumlin Gap and that the apparent offset by faulting may be due instead to the change in amount of dip along the strike from 50° to almost vertical.

Little Canoe Creek.—Southwestward about three-fifths of a mile to the gap of Little Canoe Creek no prospects and only sparse ore float were noted. On the north bank of the creek an old prospect drift, (Pl. 2, 19) reported to have been made about 1902, exposed 3 feet of dark sandy ferruginous material. The strata are disturbed and are overturned so as to dip 45° southeast. Noted on the dump were traces of the large fossil corals similar to those found in the thick ore bed at the head of the Cove.

South-southwestward from Little Canoe Creek for about three-fifths of a mile ore float is found on the hill slopes but most of the prospect openings showed little or no ore. In a valley on the east side of the ridge in the SW cor. SE¼ SE¼ sec. 13, T. 12 S., R. 3 E., drifts were noted in the ore bed on each side of the valley. (Pl. 2, 21) The beds are overturned and dip 75° east. Analyses of two samples of ore from these drifts in SW cor. SE¼ SE¼ sec. 13, T. 12 S., R. 3 E., showed the following constituents:

Analyses of iron ore from south of Little Canal Creek

Sample	FeO	SiO_2	Al_2O_3
1.	10	58	19
2.	28	36	13.6

Another test pit in this vicinity showed a seam 1 foot 6 inches thick carrying 21 percent of iron and about 60 percent of silica plus alumina. The rocks are overturned and dip 39° east.

McLendon Gap.—McLendon Gap, in the middle eastern part of sec. 24, T. 12 S., R. 3 E., is eight-tenths of a mile south of Little Canoe Creek. An analysis of a sample from this gap, cited by McCalley (M II, p. 282), averaged from an upper bench 1 foot 6 inches thick and a lower bench 6 inches thick and dried at 105°, gave 35.8 percent of iron, 10.45 percent of silica, 20.06 percent of lime, and 0.382 percent of phosphorus, obviously indicating a fairly good grade of hard ore.

Samples of ore taken from a water level drift on the north side of the road at McLendon Gap were analyzed by David Hancock ot Birmingham. The hard ore was reported as the main seam, 6 feet 6 inches thick; the soft ore was reported as "No. 2" seam, but no thickness was given. The analyses are as follows:

Analyses of hard and soft iron ores from McLendon Gap

	Hard ore	Soft ore
Metallic iron(Fe)	16.70	38.30
Insoluble material	3.90	31.30
Lime(CaO)	34.80	1.60

In 1913 records were made of ore beds displayed in seven openings driven on the northeasterly strike of the rocks on the north side of McLendon Gap. (Pl. 2, 21) Two trenches not far above the road showed a dark-red soft, porous ore containing an abundance of fossils, including large corals. One of these sections is as follows:

Section of iron ore bed on north side of McLendon Gap

	Ft.	In.
Shale and sandstone		
Ore, soft, good	3	3
Ore, shaly, poor	1	2
Shale		

Dip 25° - 29° S. 83 W. Total ore, good and poor, 4 feet 5 inches.

The following section is reported from the second level above the road:

Section of iron ore at second level above road on north side of McLendon Gap

	Ft.	In.
Ore, clayey, black and yellow bands	1	1
Ore, red, fossiliferous, fairly firm	1	6
Ore, clayey	2	5

Dip 47° NW. Total ore about 5 feet.

An analysis of a sample from this place showed 46 percent of iron, 13 percent of silica, 8 percent of alumina, 1.4 percent of lime, 0.8 percent of phosphorus, 0.5 percent of manganese, and 15 percent of water.

In the third drift above the road a bed 5 feet 1 inch thick was sampled, but only about 4 feet was reported as good ore. The ore was semihard to hard except for the top foot, which was nearly a soft ore. The average for the material showed 34 percent of iron, 4.9 percent of silica, 3.2 percent of alumina, 18.8 percent of

lime, 0.36 percent of phosphorous, 0.28 percent of manganese, and 8.8 percent of water.

In the fourth drift above the road the ore bed was about 5 feet thick and dipped 26° NW. The top 10 inches was reported as lean, rotten ore, somewhat sandy, with 4 feet 2 inches of semi-hard to hard ore below. An average of analyses of nine layers of this bed gave 37 percent of iron. 6 percent of silica. 3.7 percent of alumina. 15 percent of lime, and 11 percent of water. The bottom 2 feet was of low grade material. carrying only 12 to 27 percent of iron and 25 to 39 percent of lime.

In the fifth drift above the road level a thickness of about 8 feet of ferruginous material is shown. The upper 4 feet of the bed showed on analysis 44 percent of iron, 13 percent of silica. 8 percent of alumina, no lime, and 12 percent of water. but the lower 4 feet showed 16.5 percent of iron, 44 percent of silica. 20 percent of alumina, no lime, and 12 percent of water. An average of the two analyses shows only a little more than 30 percent of iron

The sixth and seventh drifts above the road are connected by a raise. In the lower of these two drifts a fault cuts the ore which is 4 feet thick. The upper drift contains 4 feet of ore dipping 27° NW, and considerable soft ore is reported to have been mined here. The last mentioned drift is on the crest of the hill, about 200 feet above the road.

In 1938 all of the drifts were caved and could not be entered, but ore was being mined from an opening 140 feet above the road. Mining continued intermittently for a year or two, but had stopped in 1941. The mine was worked to a depth of over 200 feet on the "big coral" bed. The ore is fossiliferous, rather friable, and about 4 feet thick.

Old test pits are found in several places on the east slope of the ridge. From the small amount of ore seen in place, and from float ore, the "low phos" and "sandy" beds are probably present on this ridge. The attitude of the beds suggest that they are somewhat out of position because of faulting.

Two partly caved drifts (Pl. 2, 22) driven on the "big coral" bed on the south side of McLendon Gap were noted in 1928. A

soft, sandy, fossiliferous ore bed nearly 4 feet thick dipping northwest was noted in the lower drift. The upper drift, about 130 feet higher than the road, was reported to show 3 feet 6 inches of ore 80 feet from the mouth of the opening. The ore dipped steeply northwest. Analysis of a sample showed 47 percent of iron, 9 percent of silica, 6 percent of alumina, 3.7 percent of lime, and 18 percent of water.

In 1937 all of the many openings on ore beds south of McLendon Gap were slumped and the mine timbers were rotting away. With a few exceptions, the ore beds were partly or wholly obscured. Most of the mining was done before 1930. The amount of ore mined at Tumlin Gap and near McLendon Gap had justified the building of a narrow gauge tramway from the Louisville and Nashville Railroad at Tumlin Gap Station southward along the ore-bearing ridge to a point about half a mile south of McLendon Gap. The tramway was in operation as late as the fall of 1929, but had been removed several years before 1937.

In the SE¼ sec. 24 and in the north part of NE¼ sec. 25, T. 12 S., R. 3 E. the ore beds crop out for about half a mile on two parallel ridges. The strike of the beds in the two ridges is almost north. The beds in the west ridge dip generally west-northwest at moderately steep angles. The beds in the east ridge are folded and faulted and show a great diversity in direction and amount of dip.

South of McLendon Gap, West Ridge.—The outcrop of the "big coral" bed can be traced from McLendon Gap southward along the east slope of the west ridge by a series of drifts, trenches, and slopes. The ore mined was soft and fossiliferous and was from a bed which obviously ranged in thickness from about 3 feet to 4 feet 6 inches. Differential movements of the strata by folding and faulting are probably responsible for the variation in thickness from place to place, and also for differences in direction of dip. Differences in original deposition have played a part in these variations.

About a quarter of a mile south of McLendon Gap, there were noted two drifts in the hillside. In the north drift the ore was 2 feet thick and dipped 18° northwest. An analysis of the full thickness of the bed showed 48 percent of iron, 11 percent of silica,

8 percent of alumina, no lime, 0.3 percent of phosphorus, and 8 percent of water. The south drift showed a bed of lower grade ore 4 feet 6 inches thick which dipped 75° northwest. This ore showed on analysis 40 percent of iron, 20 percent of silica, 10 percent of alumina, 0.90 percent of lime, 0.7 percent of phosphorus, and 15 percent of water. The data suggest that two different beds are exposed. The bed exposed in the north drift may be the "low phos" bed and that in the south drift, may be the "sandy" seam. The difference in altitude is presumably due to a fault.

A drift 180 feet long about opposite the end of the narrow gauge tramway was examined in 1929. (Pl. 2, 25) The ore bed here is about 4 feet 6 inches thick and dips more than 50° northwest. A sample taken in this drift was reported to have contained 53 percent of iron, 7.3 percent of silica, 5.5 percent of alumina, no lime, and 8.5 percent of water.

About 300 feet south of the end of the tramway a test pit exposed an ore bed 3 feet 6 inches thick, dipping 66° southwest. The soft ore averaged 54 percent of iron, 6.4 percent of silica, 6.5 percent of alumina, no lime, and 13 percent of water. About 80 feet east of this pit a well was put down on another bed of ore. The bed is 1 foot 3 inches thick, dips 42° southwest, and contains 38 percent of iron, 25 percent of silica, 12 percent of alumina, no lime and 11 percent of water.

Except in the instances mentioned above, little evidence of the two lower beds ("low phos" and "sandy" seams) is shown on the west ridge. Faulting has probably eliminated other outcrops.

South of McLendon Gap, East Ridge.—The strata exposed in the short east ridge south of McLendon Gap represent only the lower part of the Red Mountain formation. The Ordovician Chickamauga limestone crops out near the bottom of the ridge on the east side. All of the red ore outcrops are on the same bed, repeated in several places by folding and faulting. This bed is stratigraphically the lowest of the three easily recognizable beds of red ore in this vicinity—namely, the "low phos" bed.

The strata near the crest of the ridge were folded to form a low syncline between two anticlines. The syncline strikes about north-northeast. Along the same strike, 1.7 miles north-northeastward, in the low syncline in Chickamauga limestone is the

"Bald Hill." It seems possible that the folds in the ridge and hill are the eroded remnants of prominent drag folds developed on the northwest limb of the Greasy Cove anticline.

The strata in the ridge are disrupted by at least two high angle faults, and probably more. The faults strike almost with the trend of the ridge. Because of the folds and faults the ore beds have diverse attitudes, and are so disrupted that mining of them was unsatisfactory.

The structure of the strata is indicated in a number of workings of ore beds in the west slope of the ridge. At the northern end of the ridge at an altitude of 980 feet the ore bed crops out around the nose of a small unsymmetrical syncline. (Pl. 2, 23) At this point the east limb of the syncline dips 72° S. 25° W. but in the west end of a large test pit 20 feet higher on the ridge the bed dips 32° S. 58° E. In the east end of the same pit the bed dips 80° N. 66° W.

The west limb of the syncline dips 26° S. 62° E. An almost continuous trench on the ore bed follows this limb 200 feet southward to the head of a small valley which is 1700 feet south of the road through McLendon Gap. A prospect opening (Pl. 2, 24) in this valley displays a 4 foot thick bed of firm, crinoidal ore, dipping 48° S. 55° E., and overlain by a thick bed of sandstone. Fifty feet north of this prospect and 10 feet lower in altitude a 4-foot bed of similar ore crops out along the strike a distance of about 100 feet. This bed is apparently a segment of the ore bed on the downthrow side of a local fault.

The ore crops out again at 920 feet altitude in the small valley mentioned above. The bed is about 4 feet thick, dips 55° almost west, and is overlain by a thick bed of sandstone. Drifts have been driven north and south on the ore bed.

Forty feet lower in the same valley, and 10 to 20 feet higher than the tramway, a rock tunnel was driven almost east into the ridge. The tunnel encountered the ore bed last mentioned above at 83 feet from the entrance, where the ore measured 4 feet 6 inches thick. Right and left levels and an upraise were driven from the tunnel. The strike of the ore bed to the south is sinuous and the right level does not follow a straight course. At 150 feet from

the tunnel the ore is about 3 feet thick and dips 55° W. Two analyses showed the ore to be hard, containing 24 to 25 percent of iron, 5 to 7 percent of silica, 2.9 to 4.2 percent of alumina, 26 to 31 percent of lime, 0.34 to 0.38 percent of phosphorus, 0.3 percent of manganese, and 1.7 percent of water. Toward the north in the left level the ore changes in character to soft, and at a distance of 100 feet from the tunnel a face 3 feet 7 inches thick dipping 84° W. showed the following analysis: Iron, 40 percent; silica, 22 percent; alumina 11 percent; lime 0.30 percent; water 17 percent. The ore thins to the north.

The presence of other outcrops higher on the slope of the ridge indicated that a second bed would be encountered, and the rock tunnel was driven farther into the ridge. About 144 feet beyond the ore bed the dip of the strata changed abruptly to nearly horizontal, and the tunnel had to be turned upward to cut across the strata, which consisted of very hard calcareous sandstone. No other bed was found before the tunnel was abandoned. These facts further substantiate the explanation of the structure given above.

In another valley 500 feet south of these workings are a number of openings (Pl. 2, 26) in which the ore bed showed a thickness up to 3 feet 6 inches. The beds are greatly disturbed, and no ore outcrop shows the same strike for any distance. The dip of the ore bed from place to place is west, northeast, and southeast, and is generally steep. The ore bed appears to crop out near the crest of the ridge on the east slope, but few prospects were made, and the bed cannot be traced.

The two ridges of Red Mountain on opposite sides of Greasy Cove join to form a small central cove developed on an anticline between them. Red ore beds do not crop out in continuous traces from one ridge to the other, but are separated by a local fault along which strata at the end of the southeast ridge were thrust over those at the end of the northwest ridge. The fault apparently crops out near the axial line of the anticline, and strikes with the fold. Directions of dip vary from place to place in relation to the position of the strata on the crest of the southwestward plunging anticline. The ore beds, cropping out in the valleys and on the low hills formed by erosion of the moderately dipping strata, have a sinuous trend.

Beginning about 500 feet south of the north line of sec. 25, T. 12 S., R. 3 E., the strata are less disturbed than in the ridges to the north, and outcrops of the ore beds can be traced south and southeastward to the point where they terminate against the fault in the SE¼ sec. 25. Many openings were made on all three beds but the most extensive mining was done on the "big coral", or stratigraphically highest, bed. The most active mining took place prior to 1930. In 1937 no work was going on in this vicinity and all of the openings were caved and filled with debris. In 1941 three slopes (Pl. 2, 27) were worked for soft ore on the "big coral" bed in the NE¼ NW¼ sec. 25 to depths ranging from about 75 to 200 feet. The ore bed dips almost west and averages from 4 to 5 feet in thickness. The ore is porous, friable, and fossiliferous, and contains many large fossil corals. The openings had caved and were not being worked in January 1942.

A short distance south of Locality 27 a record was made of a prospect on an ore bed, probably the "low phos" bed, which measured 2 feet 6 inches in thickness and dipped 18° west. Analyses reported by the Gulf States Steel Company averaged about the following percentages: Iron, 52; silica, 8.4; alumina, 7.6; no lime; and water, 15. Three analyses made by David Hancock, of Birmingham, of soft ore from this vicinity are shown in the table, page 99.

In 1913 some open cuts and a drift on the west side of a small hollow that opens toward the south were examined. (Pl. 2, 28) The openings were mostly in the NW¼ SE¼ sec. 25, T. 12 S., R. 3 E. A section of an ore bed measured in one of the drifts is as follows:

Section of iron ore bed in mouth of drift from open cut near head of Greasy Cove, NW¼ SE¼ sec. 25, T. 12 S., R. 3 E.

	Ft.	In.
Sandstone	8	
Shale, limy	13	
Ore, good		9
Ore, dirty		7
Ore, good		2
Ore, dirty	1	1
Ore, good	1	8
Ore, dirty		11
Ore, good	1	3
Shale		

Dip about 8° to 11° S. 30° W. Total ore, 6 feet 5 inches.

On the east side of the same hollow the bed was from 3 feet 6 inches to 5 feet in thickness. Stripping of the cover reached a depth of 10 to 15 feet. The openings were made on the "big coral" bed.

Workings in this vicinity were examined again in 1928 when ore was being mined from these openings. One open cut was about 500 feet long from northeast to southwest and 25 to 50 feet wide. Measurements of the thickest faces showed 6 feet 6 inches to 7 feet 6 inches of dark red, thoroughly leached hematite containing a little limonitic material. In places near the bottom of the bed are many flat pebbles of ore. The soft ore extends as far into the hill as stripped or as drifts have been driven distances of 85 feet to 125 feet from the former outcrop.

A sample from an ore bed 6 feet 6 inches thick taken 65 feet within the northwest drift showed an average of 52 percent of iron, 7.6 percent of silica, 4 percent of alumina, 2 percent of lime, 0.56 percent of phosphorus, 0.21 percent of manganese, and 17 percent of water. Other analyses of lump soft ore shipped from this place to the Gulf States Steel Company at Alabama City (now the plant of the Republic Steel Corporation) ranged from 41 to 56 percent of iron, 7.4 to 16 percent of silica, 2.5 to 7.8 percent of alumina, 0 to 0.78 percent of lime, 0.21 to 0.64 percent of phosphorus, 0.10 to 0.37 percent of manganese, and 8.3 to 12.3 percent of water. On the east side of the hollow a sample of ore from a face 4 feet 4 inches high averaged 47 percent of iron, 15 percent of silica, 8 percent of alumina, no lime, and 15 percent of water. This bed dipped 18° S. 30° W. Two slopes were driven on the east side of this hollow but in 1937 they had caved and could not be entered. No ore was worked in this vicinity between 1937 and 1942. An ore bed exposed on the face of one of the old cuts measured 7 feet 2 inches in thickness.

The "low phos" bed does not crop out in this hollow, but is traced just below the crest of the ridge on the opposite side from the head of the hollow. The "sandy" seam crops out in the hollow but little attention has been paid to it because of its low quality. The "sandy" and "big corals" beds, dipping southwestward at a greater angle than the gradient of the hollow, form V-shaped outcrops in the hollow.

Before 1913 several drill holes were put down to the ore bed a few hundred feet to nearly a mile west of the outcrop in secs. 25 and 36, T. 12 S., R. 3 E. Three records of holes, which are given below, were furnished the Geological Survey by the late Henry Badham, of Birmingham. Thicknesses of strata given are not corrected for dip, but are greater than the normal thicknesses would be. Locations are given as reported but they could not be checked precisely with maps available at the time nor could the sites of the holes be located and plotted on the present topographic base map, Plate 2.

Record of bore hole no. 1 in the NW¼ SE¼ sec. 25, (?) T. 12 S., R. 3 E., near head of Greasy Cove

	Thickness		Depth	
	Ft.	In.	Ft.	In.
Dirt	3		3	
Slaty limestone	22	7	25	7
Fire clay	8	7	34	2
Black shale	27	5	61	7
Sandy shale	107	7	169	2
Iron ore	4	4	173	6
Lean iron ore	5	1	178	7
Sandstone	10	1	188	8
Lean iron ore	14	9	203	5
Sandy shale	26	5	229	10

The 4 feet 4 inches of iron ore at a depth of 169 feet 2 inches to 173 feet 6 inches showed on analysis 29.58 percent of iron, 3.95 percent of silica, 3.80 percent of alumina, 22.62 percent of lime, and 0.39 percent of phosphorus, according to Mr. Badham.

Record of bore hole no. 2 in the NW¼ SE¼ sec. 25, (?) T. 12 S., R. 3 E., near head of Greasy Cove

	Thickness		Depth	
	Ft.	In.	Ft.	In.
Dirt	3	1	3	1
Shaly limestone	66	7	69	8
Fire clay	2		71	8
Limestone	12	6	84	2
Iron ore	2	8	86	10
Shaly limestone	7	11	94	9
Lean iron ore	8	6	103	3
Sandstone	3	11	107	2
Lean iron ore	7	6	114	8
Shale	1	5	116	1
Lean iron ore	2	9	118	10
Limestone	3	5	122	3
Shale	4	5	126	8
Limestone	1	7	128	3

The 2 foot 8-inch bed of iron ore beginning at a depth of 84 feet 2 inches was reported to have shown on analysis between 26 and 27 percent of iron.

Record of bore hole no. 3 in the NW¼ SW¼ sec. 25, (?) T. 12 S., R. 3 E., near head of Greasy Cove

	Thickness		Depth	
	Ft.	In.	Ft.	In.
Dirt	9	3	9	3
Sandstone	4	5	13	8
Limestone	14	1	27	9
Sandstone	3	4	31	1
Shaly limestone	29	4	60	5
Lean iron ore		4		
Good ore	2	6	63	7
Lean ore		4		
Limy shale	2	5	66	

An analysis of 2 feet 8 inches of iron-ore seam indicated above is reported to have shown 22.48 percent of iron, 2.68 percent of silica, 2.09 percent of alumina, 31.08 percent of lime, 0.26 percent of phosphorus, and 0.14 percent of manganese.

The following is a section of a bore hole made by a chilled-shot drill cutting a 4½-inch core:

Record of bore hole in NW¼ SW¼ sec. 25, (?) T. 12 S., R. 3 E., near head of Greasy Cove

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Alluvial	6		6	
Sand, gravel, and boulders	24	6	30	6
Chert (flinty matter)	1	6	32	
Fossiliferous limestone	52	6	84	6
Chert (flinty matter)	2		86	6
Sand and gravel	2	6	89	
Chert		6	89	6
Sandstone	1	6	91	
Chert	1		92	
Light-gray shale	4		96	
Black shale	23	6	119	6
Limestone and shale	19	6	139	
Limestone	74	4	213	4
Fossiliferous lean iron ore	4	8	218	
Dark-gray shale		8	218	8
Fossiliferous iron ore (Sample A)		10	219	6
Iron ore (Samples B, C, and D were saved; the remainder was soft and washed away)	1	10	221	4
Iron ore high in lime (sample F)	4	5	225	9
Limestone (sample G shows contact with iron ore)		6	226	3

Southeast side of the Cove.—The Red Mountain ridge on the southeast side of Greasy Cove begins in the northern part of sec. 36, T. 12 S., R. 3 E., and extends northeastward as a foothill ridge on the northeast side of Chandler Mountain. The southwest end of the ridge is about half a mile farther southwest than the end of the ore-bearing part of the northwest ridge.

An ore bed exposed in an old prospect on the southwest side of a small creek in the NE¼ NW¼ sec. 36, T. 12 S., R. 3 E. is the farthest southwest outcrop of a red ore bed seen in Greasy Cove. The ore is sandy and lean, and probably is the "sandy" seam. About 500 feed farther southwest the outcrop of the Red Mountain formation apparently ends against a fault.

On the northeast side of the creek mentioned above in an old drift (Pl. 2, 29) the "big coral" bed, about 2 feet thick, is exposed dipping 9° S. 25° E. Pieces of ore on the dump are porous and

limonitic, and contain thin shaly streaks. Another old opening on the "sandy" seam lies to the northwest of the drift.

Five hundred feet north of this drift a prospect trench was made in 1939 along the strike of the "big coral" bed near the crest of the slope on the northwest side. (Pl. 2, 30) The ore bed was almost horizontal and showed the following section:

Section of iron ore bed in NE¼ NW¼ sec. 36, T. 12 S., R. 3 E.

	Ft.	In.
Ore, mixed with clay		6
Ore, soft, firm. fossiliferous	2	1

Dip about 10° SE. Total ore 2 feet 7 inches.

For half a mile northeast of the last mentioned prospect the outcrop of the "big coral" bed lies near the northwest crest of the ridge, but the outcrop crosses the crest of the ridge in the SE¼ sec. 25, T. 12 S., R. 3 E., and for almost a mile to the northeast lies on the northeast side of the ridge. An old drift in the NW¼ SW¼ sec. 30, T. 12 S., R. 4 E., a few old test pits, and float ore show the trace of the bed.

Little prospecting has been done on the "low phos" and "sandy" seams in this vicinity. The data obtained show that the "low phos" bed crops out near the crest of the northwest slope of the ridge in the SW¼ sec. 30, T. 12 S., R. 4 E. and the "sandy" bed crops out on the crest or near it on the southeast side. The two beds end at the southwest against the fault in the SE¼ sec. 25, T. 12 S., R. 3 E.

The outcrop of the "big coral" bed re-crosses the crest of the ridge in the SW¼ NE¼ sec. 30, T. 12 S., R. 4 E. Many trenches and short drifts along the strike mark the position of the bed near the crest of the ridge, and a line of drifts follows the outcrop down into Brothers Mill Gap.

Brothers Mill Gap.—Most of the openings along the ridge in the half mile next southwest of Brothers Mill Gap obviously were made after 1928, but between 1937 and 1942 no mining was in progress and the ore beds were obscured by debris. In a drift (Pl. 2, 31) three-tenths of a mile southwest of the gap the following section was measured in 1938:

Section of iron ore bed in drift three-tenths of a mile southwest of Brothers Mill Gap

	Ft.	In.
Shale		
Ore, soft, limonitic		3
Ore, good, firm	2	2
Sandstone, ferruginous, friable		11

Dip 20° S. 45° E. Total ore about 2 feet, 5 inches.

In the half mile southwest of the gap the two lower ore beds may be present, but there is little evidence of their outcrop. A few old test pits and scant float ore were noted. On the southwest side of the gap a prospect pit obviously in the "sandy" seam showed a bed of dark sandy ferruginous material containing a few layers of hard ferruginous sandstone. A reported test of these beds showed 36 percent of iron, 23 percent of silica, 16 percent of alumina, no lime, and 17 percent of water. Other analyses of the "sandy" seam in this gap made on a dry basis, were reported by the Gulf States Steel Company as follows:

Analyses of "sandy" iron ore bed near Brothers Mill Gap

Description	Fe	SiO_2	Al_2O_3	CaO	P	Mn	H_2O
Top foot	39.82	25.50	8.95	.	0.34	0.66	......
2d foot	40.71	24.62	8.91	.....	.36	.67	......
3d foot	36.24	31.10	8.66	..	.33	.80	......
4th foot	38.43	28.64	7.11	. ..	.21	.83	......
5th foot	37.04	28.56	7.53		.29	1.04	......
Bottom sand	28.50	45.04	6.40	.. .	.26	.77	......
Test pit, 2 ft. 11 in.	41.03	17.95	6.89	None	.52	.68	15.8

Massive sandstone beds dip 29° S. 45° E. in the gap at the site of the old mill dam. About 200 feet southeast of the dam on the public road through the gap the Chattanooga shale is well exposed dipping 25° S. 45° E. with a width of outcrop of 40 feet.

Three seams of ore have been prospected on the northeast side of the road in the gap and on the hill slope above the road. The "low phos," "sandy," and "big coral" beds must have been well displayed in these prospects, but the slumping of the old workings had covered most of the ore in 1938, and only 2 feet of the "big coral" bed was visible. The two lower seams were thin and parted by shale, but contained a few inches of good granular

core. J. R. Ryan measured a section of the beds which showed 1 foot 4 inches of good soft ore overlain and underlain by shale. McCalley (II, p. 206) reported an outcrop of ore 2 feet thick in Brothers Mill Gap, but noted that to the northeast, in sec. 20, T. 12 S., R. 4 E., the ore seam is 20 to 21 inches thick with a parting of shale about 6 inches thick; in sec. 15, from 18 to 20 inches; and in sec. 12, 2 miles northeast of Chandler Mountain, about 18 inches.

Northeast of Brothers Mill, of which only the dam remained in 1937, the following section of the "low phos" bed was measured:

Section of lowest bed of iron ore on hill northeast of Brothers Mill

	Inches
Shale	
Sandstone	8
Shale	2½
Ore	5
Shale	½
Ore	3
Shale	2½
Ore	3
Shale	3
Ore	2
Shale	1
Ore	1
Clay	2
Shale	

Dip 25° S. 60° E. Total ore, 1 foot 2 inches.

Also examined was a tunnel driven 110 feet north 35° east on the strike of the "sandy" seam from a point on the outcrop not far above the road through Brothers Mill Gap. The bed is composed of dark earthy ferruginous material and has an apparent thickness of about 4 feet as exposed in the tunnel. An analysis of the material was reported to show 40 percent of iron with a high content of silica. (See also analyses of material from this bed on page 85.)

Several old mine openings were made on the "big coral" bed up the slope of the northeast side of the gap. In an old open cut, probably made in 1925-26, near the top of the hill a partial section of the bed dipping 23° S. 40° E. was measured. The bottom of the bed was covered, but 2 feet 9 inches of ore was exposed including a 2-inch scale of limonite which had replaced shale at the

top of the bed. The ore was soft, well leached, fine-grained, flaxseed-textured hematite, with a few specks of limonite. A reported analysis of ore from this bed showed 52.5 percent of iron, 8 percent of silica, 6 percent of alumina, no lime, and 11 percent of water. Graphic measurements by Burchard show that the "sandy" bed is 36 feet above the "low phos" bed, and the "big coral" bed 52 feet above the "sandy" bed. Here the lowest two beds are farther apart stratigraphically than on the outcrops on the road below.

From the crest of the ridge 220 feet above the road a slope was driven southeast down the dip of the bed. (Pl. 2, 32) From the southeast side of the ridge in a small valley in the NW¼ SW¼ sec. 20, T. 12 S., R. 4 E. a rock entry was driven N. 45° W. into the ridge for 75 feet to meet the slope. A hoist and cable were used for lowering cars down and out of the rock entry. The ore is dark, soft, and fossiliferous, and ranges in thickness from 3 to 5 feet. In the bed occasionally are found "boulders" or rounded masses of more or less ferruginous fine to coarse-grained siliceous limestone, or "jack rock", which in places occupies the full thickness of the ore bed.

Moodys Gap.—Mines were opened on the "big coral" bed before 1928 at Moodys gap, (Pl. 2, 33) half a mile northeast of Brothers Mill gap, in the NE cor. NW¼ SW¼ sec. 20, T. 12 S., R. 4 E. Five drifts were driven on the strike of the ore bed on each side of the gap at different levels down the hollow at the southeast. (See Fig. 6A) A slope was also driven down the dip of the bed beginning on the northeast side of the hollow. In 1928 soft ore had been mined along the strike of the ore bed in one drift near the crest of the ridge on the northeast sid of the gap for a distance of 650 feet. Some of the lower drifts reached hard ore at 150 feet, but hard ore was not encountered at uniform distances from the outcrop. The hard ore is usually encountered at first in the form of irregular hard boulders or "horses" surrounded by soft ore. These masses of hard ore have to be drilled and "shot" in mining.

The ore bed here dips 22° to 30° southeast, is 2 feet 7 inches to 5 feet thick, and was reported to average 3 feet 6 inches. Much of the ore is soft, fossiliferous, and firm and coherent enough to be mined in lumps, but in places near the outcrop the ore is soft

Fig. 6A. Mine drift entries in Moodys Gap on strike of red iron ore bed dipping southeast. The mountain slope is practically a dip slope.

Fig. 6B. Red iron ore from Crudup mine showing alternations of oolitic iron ore and shale.

Fig. 7. Fossiliferous red iron ore from Citico mine on Shinebone Ridge. (Natural size.)

Fig. 8A. Calcareous red iron ore showing bedded oolitic texture. (Natural size.)

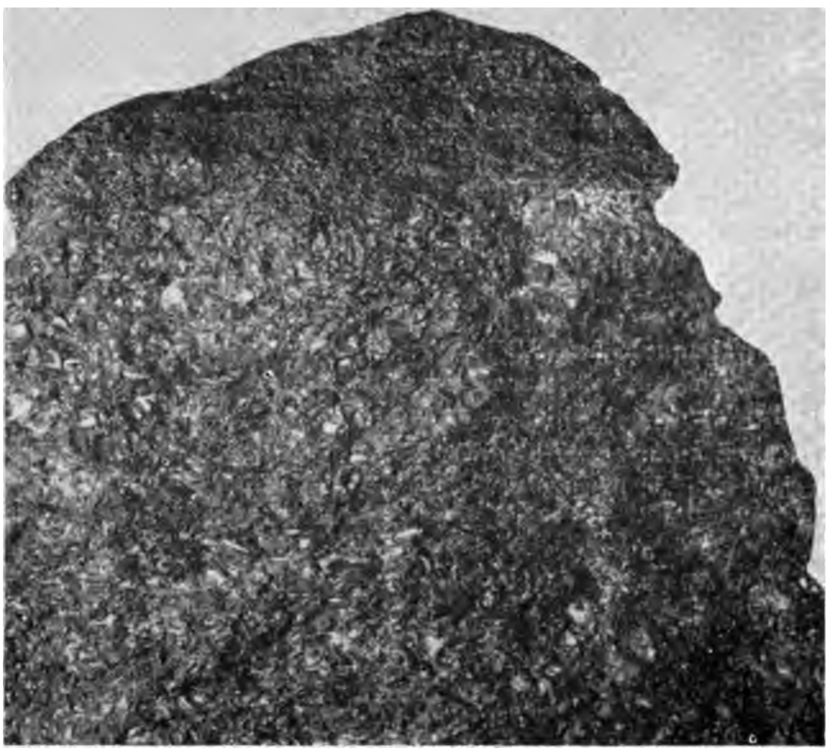

Fig. 8B. Calcareous red iron ore showing oolitic texture. Natural size.)

and friable. The ore bed is locally underlain by a gray to pink, very hard bed locally termed "jack rock" consisting of coarse quartz grains and pebbles cemented by calcite, but containing little iron.

Analyses of ore from the southwest side of the gap are reported to have averaged as follows for a thickness of 3 feet: iron, 51 percent; silica, 11 percent; alumina, 6 percent; lime, none; phosphorus, 0.23 percent; manganese, 0.18 percent; water, 13 percent. On the northeast side of the gap a face of 4 feet 6 inches of ore gave the following average: iron, 36 percent; silica, 30 percent; alumina, 9 percent; lime, none; water, 12 percent; but if only the top 3 feet is taken the percentages will be about as follows: iron, 49 percent; silica, 12 percent; alumina, 9 percent; water, 12 percent.

From the next gap one-fifth of a mile to the northeast a broad hollow, known locally as Moodys field, opens to the southeast. On the southwest side of the hollow are the openings of several drifts which in 1938 had caved and could not be entered. In August 1939 soft ore was mined from a slope in the SE¼ NW¼ sec. 20, T. 12 S., R. 4 E. (Pl. 2, 34) The slope was turned off down the dip from an old drift extending west into the ridge from a small valley on the northeast side of a projection from the main ridge. At the working face the ore measured 3 feet 11 inches in thickness and consisted of fossiliferous soft friable material with a few clay lenses. The ore, which dips 20° S. 50° E., is reported to be of good grade. The slope was not being worked in January, 1942.

From Moodys Gap for almost a mile northeastward no ore was worked for a number of years preceding 1939, but the outcrops of the beds were traced by float ore and old prospect pits. On the higher parts of the ridge the outcrop of the "big coral" bed lies along the crest, but the outcrop is V-shaped in the intervening hollows on the southeast side. The trace of the "sandy" bed is similar to that of the "big coral" bed, but the "low phos" bed crops out only on the northwest slope.

Garigues Gap.—Garigues Gap, in the SE¼ SE¼ sec. 17, T. 12 S., R. 4 E., was the scene of considerable mining activity as late as 1929. Ten or eleven drifts were excavated on the strike of the "big coral" bed on the southwest side of the gap. The drifts were

opened at different levels from the crest down the southeast side of the ridge into the deep hollow southeast of the gap. The ore bed dips 22° to 28° southeast, and is from 3 feet 6 inches to 4 feet thick. The bed lies near the surface, and the dip is only a little more than the slope of the ridge, so the ore was soft for a long distance down the dip. Analyses of 4 feet of this ore bed showed an average of 50 percent of iron, 11 percent of silica, 6 percent of alumina, no lime, and 23 percent of water.

All of the drifts were filled with debris in 1937 and could not be entered. In 1939, three drifts were opened near the crest of the ridge (Pl. 2, 35) and worked for a short time. In the northeast drift the following section on the "big coral" bed was measured at the working face 50 feet from the outcrop:

Section of iron ore bed near crest of ridge on southwest side of Garigues Gap.

	Ft.	In.
Shale		
Ore mixed with clay		5-6
Ore, soft, granular, fossiliferous	2	11
Ore mixed with clay		5-6
Shale		

Dip 28° W. 35° E. Total ore about 3 feet 9 inches.

Outcrops of the two seams southwest of the gap can be traced by float ore and a few old test pits.

Northeast of Garigues Gap the "low phos" bed has been prospected in several places along the outcrop of the bed near the northeast crest of the ridge, and according to local report from one place two carloads of ore, obtained by strip mining, were shipped. On the southeast slope of the ridge the ore was mined for a distance of about 75 feet from an open cut and a drift. The bed dips 18° to 23° S. 45° - 50° E. and ranged in thickness from 1 foot 1 inch to 1 foot 11 inches at a place about 2200 feet northeast of the gap.

Analyses of ore from this seam sampled at four places within half a mile northeast of Garigues Gap showed a range in percentages about as follows: Iron, 41 to 51; silica, 15 to 20; alumina, 6.6 to 8.7; phosphorus, 0.08 to 0.70; manganese, 0.06 to 0.17; water, 7.6 to 9.4; and none showed any lime.

The trace of the "big coral" bed disappears about 1,000 feet S. 70° E. from Garigues Gap in a small valley trending southwest in the SW¼ SW¼ sec. 16, T. 12 S., R. 4 E., at an elevation of about 840 feet (Pl. 2, 36) In many of the prospect openings and mines from the head of the Cove northeastward to this locality the "big coral" bed is underlain by the coarse-grained ferruginous calcareous sandstone known locally as "jack-rock". In the small valley referred to above the "jack-rock" is well-exposed in a wash where strata in place can be observed for 20 feet or more, but the "big coral" bed does not crop out. From this point to the end of the ridge 7½ miles northeastward a careful search failed to reveal any outcrop or float ore of the bed. No openings on this bed have been observed northeast of Garigues Gap. For these reasons the "big coral" bed is thought to lense out and disappear in the vicinity of the gap.

Northeastward from Garigues Gap the "low phos" bed has been prospected in many places along the strike of the ore. In most places the bed crops out high on the northwest slope near the crest of the ridge. The "sandy" bed crops out on the southeast slope of the ridge but has been prospected in only a few places. The outcrop of the sandy bed is traced by accumulations of blocks of soft ore filled with the numerous coarse, well-rounded quartz grains which seem to characterize the bed.

Turleys Gap.—At Turleys Gap in the SE¼ NE¼ sec. 16, T. 12 S., R. 4 E., the "low phos" bed is exposed in a short slope on the southeast side of the gap on the northwest side of the ridge. (Pl. 2, 37). The ore bed is 3 feet 6 inches to 3 feet 7 inches thick including a wedge or "middleman" of sandstone 2 to 5 inches thick at the outcrop but which disappears a few feet down the dip. The ore bed dips 25° S. 20° E. The ore is soft at the outcrop but changes abruptly to hard ore at the face of the slope 10 feet down the dip from the surface. A sample of the hard ore averaged from the full width of the bed, 3 feet 7 inches, showed the following percentages: iron, 33; silica, 18; alumina, 8.24; lime, 11.25; phosphorus, 0.29; manganese, 0.18; and water, 12.5.

Analyses of randon hand specimens of the hard and soft ore from this prospect slope by Dr. R. S. Hodges of the Geological Survey of Alabama showed the following percentages:

Analyses of iron ore from Turleys Gap

	Hard ore	Soft ore
Iron (Fe)	26.89	50.39
Silica (SiO_2)	7.64	15.03
Alumina (Al_2O_3)	6.73	6.13
Calcium Oxide (CaO)	26.44	1.78
Phosphorus (P)	.21	.56
Manganese (Mn)	.06	.10

From Turleys Gap northeastward for 2 miles to the road which passes through the gap in Red Mountain ridge in the NE¼ sec. 11, T. 12 S., R. 4 E., south of Clear Creek School, are a few old prospects in the "low phos" bed, but none in which the ore could be measured. On the west side of the road in the gap a seam of soft ore 3 to 4 inches thick was noted.

The "low phos" bed has a sinuous outcrop for half a mile northeast of the gap. The dip of the bed and the angle of slope of the southeast side of the ridge are almost equal. For this reason the bed crops out not only on the north side of the ridge, but also in a small east-west trending valley which cuts transversely across the southeast slope, and is almost parallel to the strike of the ridge. Many old prospects and some comparatively new ones were observed in this vicinty.

An exposure of 1 foot 3 inches of soft ore was noted on the ridge near the east line of sec. 11, T. 12 S., R. 4 E., and in the western part of section 12 a thickness of 2 feet of good soft ore occurs in a ravine on the southeast slope. In 1937 a number of prospects were opened on the bed in the transverse valley on the southeast slope in the N½ SW¼ sec. 12, T. 12 S., R. 4 E. (Pl. 2, 38). The ore bed dips 10° to 15° S., and ranges in thickness from 8 inches to 1 foot 8 inches.

Shores Gap.—In the SW¼ of sec. 7, T. 12 S., R. 5 E., erosion has cut so deeply into the Red Mountain formation as to nearly, if not wholly separate the areas of iron ore-bearing strata northeast and southwest of Shores Gap and to expose the underlying Chickamauga limestone well up on the northwest side of the gap. The lower part of the Red Mountain formation crosses this gap, however, with a low dip to the southeast.

The outcrop of the "low phos" bed may be traced eastward on the north side of the ridge by old trenches along the strike to Shores Gap, in the SW¼ sec. 7, T. 12 S., R. 5 E. Shores Gap lies on the axis of the low crossfield which separates the main Chandler Mountain syncline from the small syncline northeast of the gap. Along the axis of the cross fold erosion has removed the strata of the formations overlying the Red Mountain formation at Shores Gap, and the upper part of the Red Mountain formation itself including the "sandy" bed. The "sandy" bed does not cross the gap, but its outcrop swings southward with the outcrop of the Red Mountain formation into the ridge southeast of Chandler Mountain (pages 54-57). Erosion has not cut deeply enough to separate the outcrops of the "low phos" bed southwest and northeast of Shores Gap, and the bed has a V-shaped outcrop south of the gap.

Northeast of Shores Gap in one place (Pl. 2, 39) the "low phos" bed was under thin cover for some distance down the dip from the outcrop, and was mined in 1937 by stripping. Higher on the ridge trenches were cut on the outcrop. Ore was mined here in 1939 also, but the total production for 1937 and 1939 was small. The ore bed ranges in thickness from 6 inches to 1 foot 4 inches and dips 16° S. 40° E. The ore, worked out in lumps up to 3 inches thick, disintegrated rapidly when exposed to the weather.

Analysis of a picked sample of "low phos" soft ore from Shores Gap made by Dr. R. S. Hodges of the Alabama Geological Survey, showed the following percentages: iron, 54.52%; silica, 13.52%; alumina, 6.36%; lime oxide, .16%; phosphorous, .04%; manganese .08%; and loss on ignition, 2.20%.

From Shores Gap to the end of the Red Mountain ridge 3 miles northeastward the outcrop of the "low phos" bed can be followed along the northwest side of the elliptical synclinal basin near the crest of the ridge. Many pits and trenches have been dug along the strike of the bed, but all are small, and in 1938 they had not been worked for several years. A few prospects and considerable float ore show the trace of the "sandy" bed. In a few places several tons of siliceous ore in blocks 8 or 9 inches thick have accumulated. When examined in 1937 this bed showed no evidence of recent prospecting. The two beds terminate against

a fault at the northeast end of the ridge in the SW¼ sec. 33, T. 11 S., R. 5 E.

Fossils closely resembling **Pentamerus oblongus** were noted in a stratum near the top of the Red Mountain formation in the NE¼ sec. 5, T. 12 S., R. 5 E. (Pl. 2, 40) Similar forms occur in the faulted area near the NW cor. sec. 4, T. 12 S., R. 5 E.

The best possibility of recovery of ore seems to be on the northwest rim of the basin in sections 6 and 7, T. 12 S., R. 5 E., where a thin bed of ore lies at or near the surface on the southeast dip slope. The loose ore present might be recovered and the overburden where present could be removed by scrapers in order to get the ore below. The operation would thus be in the nature of a stripping. Even here, however, the quality of ore available is not great because some that was originally present has been removed by erosion.

Moragne Mountain.—The outcrop of ore on Moragne Mountain is shown for convenience on the Greasy Cove Map, Plate 2, because greater detail is afforded on this modern topographic base than on Plate 3 which accompanies the description of Wills Valley. The details of the ore beds in Moragne Mountain are described in the text on Wills Valley as Moragne Mountain forms the southwest terminus of the Red Mountain ridge on the southeast side of that valley.

PEBBLES OF IRON ORE

A noteworthy and interesting feature of the ore in the bed at Schoolhouse Gap, as shown in the dumps from shaft and tunnels, is the presence of many peculiar flat pebbles or "kidneys" of iron ore. (See p. 47.) These pebbles range in thickness from one-eighth to three-fourths inch, and in diameter from half an inch to 6 inches, though most of them are 2 to 3 inches in diameter. The flat sides of the pebbles show slight pitting due to the action of solution and abrasion on uneven-textured material, and the surfaces are coated with soft, shiny amorphous hematite, probably derived from the beds in which they lie. When broken the pebbles are found to consist chiefly of calcareous granular hematite typical of the Red Mountain iron-ore beds, but some of them are composed of fine-grained sandy limestone more or less ferruginous. These pebbles are

found in both the "hard" or limy condition, and the "soft" or non-limy condition, corresponding to the condition of the enclosing bed of ore, which is generally hard below a depth of 85 feet in this shaft. The shape of the pebbles indicates that they have been subjected to wave action long enough to round the edges t osome extent but not enough to produce typical well-rounded gravel. The distribution of the granules of hematite and streaks of calcite in the pebbles of ore indicates that they have been split from a bed of ore along the bedding of the sediments, and the position of the pebbles within the present matrix, which is itself typical Red Mountain ore, is parallel to the bedding. The pebbles contain small fossils, among which crinoid buttons and fragments of imperfectly preserved corals and brachiopods are readily discernible. The evidence thus far adduced indicates that the pebbles were derived from ore-bearing beds that had been deposited and consolidated before this bed was formed. Possibly the source bed was a portion of this same bed that rose temporarily nearly to or slightly above sea level. As stated above, the pebbles occur in the basal part of the ore bed, which is the natural position for a conglomeratic deposit. (See Figs. 5A and 5B).

This deposit of ore pebbles, although unusual, is not the only one of the sort to be observed in Alabama, for similar pebbles occur at the Citico mine, on Shinbone Ridge north of Gadsden, 17 miles N. 75° E. of the Schoolhouse Gap shaft, and others have been noted by the writer in ore from the Shannon and other red-ore mines in the Birmingham district. Large discoid pebbles of limestone occur in a sandstone parting between the Irondale and Big seams of iron ore at the Helen-Bess mine, east of Birmingham,[1] which is thought to have been formed as a conglomerate.

Physical tests and analyses of ore.—The following tests and analyses mostly of rich soft ores made in connection with a private examination of the ore beds in Greasy Cove are of more than ordinary interest in that they show certain physical data such as cell, or pore, space in percent by volume and the true and apparent specific gravities of the ore. These determinations enable a comparison to be made of the porosity of the hard and soft ores at the Tumlin Gap mine but they do not indicate directly the percentage of lime that has been leached out of the hard ore in the process

[1]Butts, Charles, Geology of Alabama: Alabama Geol. Survey Special Rept. 14, p. 137, pl. 41, B, 1926.

of weathering to soft ore. If the observed relations be applied to soft ores from other openings toward the head of the Cove they might possibly give some indication as to the character of the corresponding hard ores in depth. The relations between analyses and cell space indicate that a better grade of hard ore should be expected than has actually been found and so it would be desirable if more such first-hand data were available as well as more data from drilling through the hard ores. The alumina (Al_2O_3), although higher than desirable, is not much higher than the average for the soft ores formerly mined in the Birmingham district. The thickness of the beds sampled ranges from 1 foot 6 inches to 6 feet 8 inches, but if the maximum thickness be excluded the average thickness appears to be about 2 feet 7 inches.

Physical tests and analyses of red iron ore, Greasy Cove

Dry basis

Locality	Thickness		Fe	SiO_2	Al_2O_3	CaO	Mn	P	Cell Space (Per cent by volume)	Specific Gravity	
	Ft.	In.								True	Apparent
NE¼ sec. 8, T. 12 S., R. 4 E., soft ore	2	4	58.60	9.09	4.47	0.60	.12	.31	33.03	4.42	2.96
Tumlin Gap Mine:											
Hard ore ..			21.91	4.62	3.19	28.90	.21	.57	8.97	3.12	2.84
Soft ore ..			53.62	7.72	5.43	2.87	.12	.81	33.83	4.14	2.74
South part sec. 7, T. 12 S., R. 4 E., Soft ore	2	6	57.99	7.05	4.97	.60	.08	.23	33.96	4.27	2.82
NW¼ sec. 18, T. 12 S., R. 4 E, Soft ore	1	6	57.87	5.66	5.35	.80	.26	.33	49.08	4.34	2.20
Gilliland Gap, Soft, siliceous ore	2	6	22.57	57.84	4.79	.40	.00	.11	24.36	3.12	2.36
McClendon's Gap, Soft ore	3		56.82	6.90	5.66	.40	.13	.32	43.33	4.27	2.42
Badham drift,											
Soft ore	6	8	55.48	7.36	5.42	1.45	.05	.89	37.35	4.23	2.65
Soft ore	2	11	56.68	7.71	5.52	.40	.06	.24	34.55	4.37	2.86
Near Brothers Mill, Soft ore	1	6	58.02	6.20	4.47	.20	.17	.23	39.49	4.33	2.62
Sec. 20, T. 12 S., R. 4 E., on ridge, Soft ore	3	4	57.05	7.12	5.61	.70	.27	.62	36.91	4.28	2.70

The following additional analyses of the ore in Greasy Cove are available. The first five may represent ore from the head of the Cove shipped from Tumlin Gap.

Analyses of soft and hard iron ores from head of Greasy Cove.

Description	Authority—a	Fe	SiO_2	Al_2O_3	Insoluble	CaO	P	Mn	H_2O
Lump	GS	49.55	15.58	5.37	....	....	0.35	0.13	....
Do	GS	56.00	7.40	5.49	....	....	.24	.10	8.30
Do	GS	55.43	6.74	4.68	....	0.78	.64	.37	....
Do	GS	54.01	7.80	6.22	....	....	.24	.13	12.28
Do	GS	55.43	7.38	2.48	....	....	.21	.27	....
Drill core	GS	51.25	9.34	6.28	....	2.29	....	....	....
Do	GS	41.34	22.54	7.78	....	1.15	....	....	....
Do	GS	11.91	1.34	.90	....	43.15	....	....	....
Do	GS	22.48	2.68	2.09	....	31.08	.26	.14	....
7-foot bed	P	53.65	7.72	5.66	....	1.47	....	....	....
"Big seam"	O	29.58	3.95	3.80	....	22.62	.39	....	....
Do	O	32.32	....	....	4.50	21.44	....	....	....
Do	O	35.80	....	....	4.35	16.37	....	....	....
Do	O	54.70	....	....	9.17	Tr.	....	....	....
Do	O	54.79	....	....	9.06	Tr.	....	....	....
Do	O	59.20	....	....	9.54	.12	....	....	....
Seam below "big seam"	O	54.23	....	....	18.33	.10	....	....	....
Do	O	51.84	....	....	21.66	.13	....	....	....
Do	O	51.27	....	....	21.89	.11	....	....	....
2 ft. 3 in. bed	H	53.40	7.20	6.02	....	....	.27	.14	....
2 ft. 6 in. bed	H	55.10	6.25	5.95	....	....	.25	....	....
2 ft. 2 in. bed	H	55.50	6.40	5.72	....	....	.31	.22	....
Semihard	U.S.	37.87	7.56	4.14	....	12.52	.31	.05	....

a—GS, Gulf States Steel Co. (dry basis); H, David Hancock; O, owners of property; P, Dr. Wm. B. Phillips. U. S., U. S. Geological Survey (in addition, TiO_2, 0.41, K_2O, 0.17).

RESUME OF IRON ORE RESERVES IN GREASY COVE

In Greasy Cove the approximate length of outcrop areas of the Red Mountain formation, including the borders of the elliptical basin southwest of Attalla, is about 36 miles. Within these areas there are about 6.5 miles of outcrop of beds of red iron ore 2 feet or more in thickness and about 21 miles of outcropping ore beds having a thickness of less than 2 feet. These 21 miles do not include the outcrops of overlapping beds where there is more than one bed of ore present. There are seven areas in the Cove in which the thickness of the ore beds appears to average 2 feet or more: (1) near Schoolhouse Gap, in the SE¼ sec. 34, T. 11 S., R. 4 E. ,and the NW¼ sec. 3, T. 12 S.; R. 4 E., (2) southwest of Schoolhouse Gap in the NE¼ sec. 4, T. 12 S., R. 4 E.; (3) south of Tumlin Gap in the S½ sec. 7, T. 12 S., R. 4 E.; (4) from north

of McLendon Gap to the fault at the head of the Cove; (5) three small areas on the southeast border at the head of the Cove in secs. 25 and 36, T. 12 S., R. 3 E., and sec. 30, T. 12 S., R. 4 E.; (6) from south of Brothers Mill Gap to Moodys Gap, secs. 19, 20, and 30, T. 12 S., R. 4 E.; (7) from Garigues Gap to Turleys Gap in secs. 16 and 17, T. 12 S., R. 4 E. In areas (7) the extent of the ore bed 2 feet or more thick happens not to have been shown as a solid red line on the geologic map, Plate 2, but as the presence of ore of such thickness at several places in that area has been mentioned in the text it is included among the areas for which ore tonnage is estimated. The tabular summary at the end of this chapter should be consulted in reviewing the essential data.

The dips of the strata indicate the intensity of the deformation of the beds and afford criteria as to the relative depths to which the weathered soft and semihard ore may extend and also as to the structural conditions that may affect mining. The lengths on the strike indicated in the tabulation are measured on the map and are therefore only as accurate as can be expressed on a map of this scale and character. The width on the dip to which soft and semihard ore may extend is uncertain but its estimation is more or less arbitrarily indicated by several factors noted in outcrops, prospect trenches, shafts, and mine drifts, such as the character of the roof, the dip of the beds, the thickness of overburden, and the degree to which the associated rocks are faulted and fractured. In some areas of red iron ore in Alabama the ore has been found to be soft for a greater distance than it appears to be in Greasy Cove, but for an estimate of ore tonnages, however rough, it is necessary to assume a distance down the dip and use that factor in the estimate for the given conditions. Some of the distances given in the table may be in excess of the actual soft or semihard ore limit. The apparent average thickness is derived from many measurements in some places and from only a few measurements in others so that at best it also is a figure that may be far from accurate. The number of cubic feet per ton is a factor that varies with the texture and original composition of the hard ore and will be found to differ within certain limits from place to place. The true specific gravity determined for certain ores from Greasy Cove varied between 3.12 and 4.42, and the apparent specific gravity between 2.20 and 2.96. If true specific gravity and apparent specific gravity have reference respectively to properties of pulverized ore without cell spaces and of

the natural lump ore including its cell space, then the apparent specific gravity is the factor that should be applied in the present calculations of ore tonnage. The general average for the values given for this factor on page 100 is 2.65, which corresponds with a weight of about 165.4 lbs. per cubic foot or approximately 13.5 cubic feet per long ton. This figure is appropriate for a typically porous ore such as that at the stripping mines at the head of Greasy Cove. The ores as considered herewith have been assigned volumes of 11 to 12 cubic feet per ton according as their density decreases. In no instance does it seem consistent to consider ore in Greasy Cove as approximating 10 cubic feet per long ton, which would correspond with a specific gravity of about 3.59. Experimental work on cubes and lumps of the Birmingham hard red ores showed that the specific gravities ranged from 2.93 to 3.56 which corresponded roughly to weights of from 183 to 225 pounds per cubic foot, or to volumes of about 12.25 to 10 cubic feet per long ton.[1] The Birmingham hard ores are generally denser and occupy less volume to the ton than any of the Greasy Cove ores.

Many analyses have been given in the foregoing text which indicate that the hard ore is generally low in metallic iron and high in lime and that the soft ore is high in iron but also in many instances is relatively high in alumina and phosphorus and combined water. Measurements have shown that there is a wide variation in the thickness of the ore beds along the strike and to some extent at right angles to the strike. Therefore, the possibility that, in places, the beds at some distances from the outcrop may become thicker than at the corresponding points on the outcrop must not be overlooked. Diamond core drilling appears to be the only satisfactory method of ascertaining the true conditions in this respect. Such drilling by property owners and by the Federal and State Governments may well be encouraged. At present ore having a thickness of only 2 feet is not generally considered of value for mining, but this thickness has been taken as a minimum for consideration in this report because under certain

[1]Burchard, E. F., Iron ores of the Birmingham district, Alabama: U. S. Geol. Survey Bull. 400, 1910, p. 27.

circumstances, as for instance a 2-foot bed of soft ore lying below a thin cover and having a low dip, might be mined profitably by stripping. Some soft red ore is of especial value for metallic paint and such seams less than 2 feet thick have been mined underground.

Because of the hard ore in Greasy Cove appears to be of doubtful commercial grade, consideration is given particularly to the strip of soft to semihard ore on the outcrop. It should be borne in mind, however, that there is a large quantity here of ore that is low in iron and high in lime. Such material would prove of more than ordinary value as a flux on account of the excess of iron present as compared with ordinary blast-furnace flux. Careful watch should be kept, however, to guard against an excess of phosphorus being introduced with the iron.

By use of the factors, length of outcrop along the strike (L), the estimated width of the ore area on the dip (D), the apparent average thickness (T), and the estimated number of cubic feet per long ton (N), the calculation of the ore within any given area may be made by the simple formula $\frac{L \times D \times T,}{N}$ but this does not take into acount the percentage of recoverable ore nor the quantity of ore already removed from the area estimated altogether at about 60,000 tons. The figures given in the table represent estimates made on the above basis and will serve only to show what the tonnage of soft to semihard ore would be under the given conditions. Deductions of 10 percent have been made for nonrecoverable ore and of the estimated past production.

In the present report increases in the value of D have been made amounting to 500 to 950 feet as compared with the earlier estimates published in 1933 with the result that an increase in tonnage of more than 500 percent above that of the soft and semihard ore total estimated for 1933 is indicated. In view of the unfavorable aspect of what is known of the hard ore and the continued lack of definite favorable drilling data concerning the actual presence of good ore beyond the limits now assumed it is not considered wise to sponsor a broader estimate at this time.

Summary of data on Iron ore beds, 2 feet or more thick in Greasy Cove, Alabama.

Locality	Dips	Length of outcrop on strike (L)		Estimated width on Dip (D) (feet)	Apparent Average thickness (T) (feet)	Estimated cubic feet per ton (N)	Estimated quantity-soft, semi-hard and hard ore (long tons)
		Feet	Miles				
1) Schoolhouse Gap area, SE¼ sec. 34, T. 11 S., R. 4 E., and NW¼ sec. 3, T. 12 S., R. 4 E.	Generally steep northwest but in places vertical or overturned to southeast	3,430	0.65	600	4	11	748,000
2) SW of Schoolhouse Gap in NE¼ sec. 4, T. 12 S., R. 4 E.		1,585	0.30	600	2.25	11	195,000
3) South of Tumlin Gap in S½ sec. 7, T. 12 S., R. 4 E.	45° to 60° NW	2,270	0.43	600	3	11	371,000
4) From North of McLendon Gap to fault at head of the Cove.	10° to 60° NW to vertical	9,770	1.85	600	4	12	1,954,000
Southeast border of Cove							
5) Three small areas at head of Cove in secs. 25 and 36 T. 12 S., R. 3 E., and sec. 30, T. 12 S., R. 4 E.	Low to moderate NW, S, and SE	4,600	0.87	1,000	2.3	12	882,000
6) South of Brothers Mill to Moody Gap, secs. 19, 20, and 30, T. 12 S., R. 4 E.	Horizontal to moderate (10° to 35°) SW, S, and SE	5,800	1.1	1,200	3.5	12	2,030,000
7) Garigues Gap to Turleys Gap, secs. 16 and 17, T. 12 S., R. 4 E.	Moderate, to 30° SE.	6,600	1.25	1,200	3	11	2,160,000
Total outcrop of ore beds 2 feet or more thick		34,055	6.45				
Total soft, semihard and hard ore in beds 2 feet or more thick to distances down the dip as indicated							8,340,000
Less nonrecoverable ore (10%)							834,000
Net recoverable ore Less estimated past production							7,506,000 60,000
Estimated Net Reserve Tonnage indicated and inferred recoverable ore							7,446,000

WILLS VALLEY, SOUTHEAST SIDE

(Plates 2-8)

Attalla.—The outcrop of the Red Mountain formation on the northwest limb of the Lookout Mountain syncline forms the crest of a ridge, known as Red Mountain, beginning just west of Attalla and extending toward the northeast continuously to beyond the Georgia line. South of Attalla its outcrop is cut off abruptly by the great overthrust fault against which Lookout Mountain terminates and south of which the Cambrian shale and shaly limestone of the Conasauga formation forms a broad, nearly flat valley. Folding accompanied by overthrusting of this fault has resulted in more or less deformation of the beds of the Red Mountain formation on the north side of the fault plane and has even bent their line of outcrop into a V-shaped plan which is also expressed in the topography of the ridge west of Attalla. The Red Mountain formation near Attalla is more than 500 feet thick and contains 4 or 5 beds of ferruginous material, one of them constituting a minable ore, but the others are thin or lean. The beds dip southeast only a little more steeply than the east slope of Red Mountain and crop out on the northwest just below its crest.

In the following descriptions notes will be given on the ore beds beginning at the extreme southwest end of the outcrop in Moragne Mountain and extending northeastward in Red Mountain, the ridge that lies between Wills Creek and Lookout Mountain. McCalley visited this locality in 1887 and measured a number of sections. Near the extreme south end of the ridge west of Attalla the ore bed is thin, only 8 inches being visible, with shaly partings in its upper portion.[1] (M. II, P. 222) The strike of the beds has been so twisted around here that the dip of 50° is toward the northeast. As the ore-bearing ridge is followed around to the northwest for about 1 mile, the ore seam becomes thicker and has been mined for soft ore in surface workings. A mine, at first known as the Moragne, later as the Citico, was in operation at the time of McCalley's visit. This was situated at the western point of the "V" shaped outcrop 1 mile west of Attalla. (Pl. 3, 1) On the outcrop soft ore was being obtained from a bed about 3 ft. thick carrying approximately 54 per cent metallic iron. Underground the ore

[1]Coosa Valley Report, 1897, p. 222. (In later pages of this text these references will be supplied as parentheses in the text such as M. II, page ....).

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seam was reached through a tunnel driven in from the southeast side of the mountain a distance of about 240 feet. The ore there measured about 2 ft. 8 in. thick. An analysis (No. 1, p. 111) cited by McCalley of the hard ore shows 45.36 per cent iron. This mine was first visited in 1911 when ore was being shipped to the Citico blast furnace at Chattanooga, Tennessee. The mine was entered through a rock slope driven at an angle of 20° to 25° in the direction N. 25° W. to where it intersected the ore. A main haulway extended from the rock slope along the strike of the ore bed, and about 75 feet northeast of the rock slope the first slope had been driven down the dip of the ore bed a distance of about 550 feet. About 1,000 feet southwest of the rock slope another ore slope had been driven about 220 feet down the ore bed. The dip in the northeast slope was 20° to 23° S. 25° E. and was reported to be only 13° to 15° in the southwest slope. Several sections of the ore were measured in the haulway near the base of the rock slope and the majority of them showed about 2 ft. 10 in. of practically solid, hard ore. The following section is representative:

Section of iron ore bed in Moragne (Citico) mine 1 mile W. NW. of Attalla

	Ft.	In.
Shale, or "draw slate"		6
Ore, hard, practically solid	2 to 2	9½ to 10
Shale		

Dip 20° to 23° S., 25° E.

The ore is hard, calcareous, coarsely granular, and fossiliferous, and contains irregularly shaped "kidneys," or pebbles, of argillaceous material from the size of small grains up to 1½ inches in diameter. These inclusions are not very abundant nor are the larger ones very common. The fossils include **streptelasma**, fragments of bryozoans and of trilobites. **Pentamerus oblongus** occurs in abundance in sandstone near the mouth of the tunnel, stratigraphically above the ore bed. In mining about 6 inches of shale, or "draw-slate," as it is called by the miners, comes down with the ore, and to eliminate this material from the ore a picking belt had been installed near the mouth of the mine.

Northeast of the Moragne mine is a property formerly operated by the Alabama Consolidated Coal and Iron Co., later by the Alabama Company, and finally acquired by the Sloss-Sheffield Steel and Iron Co. This property is at the "Low Gap" about 1 mile north of Attalla where the ridge bends from an east-west direction to a northeasterly direction. (Pl. 3, 2) The property is largely in sec. 34, T. 11 S., R. 5 E., but extends also into sections 33, 35, 26, and 24. For convenience this will be referred to as the Attalla mine.

Soft ore was mined extensively on the outcrop here and as early as 1887 an underground slope had been driven 600 feet down the dip of the ore bed. The soft ore is said to have extended 150 to 250 feet down the dip. The following sections were measured by McCalley, the first at the mouth of the mine slope in the "Low Gap," the second and third respectively at open cuts just southwest and northeast of the gap:

Section of upper part of Red Mountain formation at the "Low Gap" in the N.E.¼ of S.E.¼ of sec. 34, T. 11, R. 5 E.
(M. II, p. 219)

	Ft.	In.
(7) Shale, about	30	
(6) Ore, Shale; in alternate streaks, the ore is shaly, from 2 ft. to	2	6
(5) Sandstone, ferruginous and calcareous, very hard, breaking like flint and called cap rock, it seems to thicken as the ore thickens, about		8
(4) Shale	2	0
(3) Ore; good	4	0
(2) Shale		

Section of Red Mountain rocks S. W. of Low Gap
(M. II, p. 220)

	Ft.	In.
(6) Shales, Sandstones; yellowish gray with greenish tinge		
(5) Ore, Shale; very hard shaly ore full of fossil corals, called "the ore blossom"		6-8
(4) Shale	1	6
(3) Sandstone; very hard, yellowish, "cap rock", fine cover		8
(2) Shale; frequently so hard in the mines as to have to be blasted	1	6
(1) Ore	3 to 3	6

Section of part of Red Mountain formation northeast of the "Low Gap" in the NE¼ of SE¼ of sec. 34, T. 11, R. 5 E.

(M. II, p. 218)

	Ft.	In.
(7) Shale, sandstone; sandstones flaggy in seams about 2 inches thick, about	12	0
(6) Ore, shale; in alternate streaks, the ore is shaly	1	6
(5) Sandstone; flaggy, hard and ferruginous, called "cap rock"		8
(4) Shale	1	0
(3) Sandstone; flaggy, similar to (5)		2
(2) Ore; good soft	2	8
(1) Shale		

At this mine, which was operated by the Alabama Consolidated Coal and Iron Co. in November 1911, 9 sections of the ore bed were measured in the north slope, ranging from 2 feet 9 inches to 3 feet 5 inches in thickness and the ore was reported to average about 3 feet thick. The ore was hard, containing calcium carbonate in streaks, but not a large proportion of shale. Shale was observed to occur locally in streaks from the thickness of a knife edge up to 2 or 3 inches. Above the ore was a layer of shale or "draw slate" 1 foot to 1 foot 2 inches thick which was shot down with the ore, and above this shale was a layer of fine grained blue sandstone that formed a smooth roof in the mine. The beds dip 23° S. 50° to 60° E. The following section shows the character of the ore bed here:

Section of iron ore in mine of Alabama Consolidated Coal and Iron Co., 1 mile northwest of Attalla.

	Ft.	In.
Shale		
Sandstone, blue, fine grained		8-10
Shale, or "draw-slate"	1 to 1	2
Ore, hard, containing streaks of calcium carbonate and locally streaks of shale, very thin to 2 or 3 in. thick	2 9 to 3	5
Shale		

Dip 23° S. 50° to 60° E.

Measurements in the mine are reported as follows: In No. 1 slope, room 40, ore 2 ft. 9 in., with shale foot and hanging wall; it is necessary to take up some bottom shale to give sufficient height in haulway. At the top of slope No. 2 in main haulway, 3 ft. 6 in. of ore was mined. In No. 2 slope heading 3 ft. 4 in. of ore and 1 ft. 10 in. of top "draw slate" was mined. In room 53 the ore was 2 ft. 9 in. thick and in room 56 it was 3 ft. 1 in. In No. 3 slope heading there were 3 ft. 4 in. of ore topped by 1 ft. 9 in. of draw slate, and in room 53 there was 3 ft. 2 in. of ore and 2 ft. of draw slate.

The Attalla mine was operated intermittently for many years, but is reported to have ceased operations in 1926.

Several geologic and engineering examinations have been made of the property, one of them in detail by the late Dr. J. S. Grasty, in 1913. Many measurements of the ore bed in sec. 34, T. 11 S., R. 5 E., showed thicknesses of 3 ft. to 3 ft. 6 in. but decreasing toward the northeast to about 1 ft. 8 in. in the SW¼ SW¼ sec. 26, T. 11 S., R. 5 E. Some interesting relationships were brought out by Doctor Grasty in his detailed studies. For instance, he recognized a "shore line" or line of marked thinning of the ore bed, presumably due to limitations of original deposition, making an angle of about 20° with the direction of dip, and extending in a direction between S. 70° E. and S. 80° E. He also noted that local rolls, or squeezes, in the strata produce thinning and thickening of the ore bed. He recognized certain faults and many minor folds, the former displacing the bed for short distances, and the latter causing abrupt changes in the degree and direction of the dip of the ore bed. Some of these folds are in the nature of rolls, or waves in the strata, the axes being in the direction of the strike of the beds. There are also a number of transverse folds the axes of which are in the same general direction as the dip of the beds. Folds of the first type are part of the system of parallel anticlines and synclines typified respectively by Wills Valley and Lookout Mountain. There are three of them on this mining property, about 800 feet apart, and at some places they have been broken or faulted on the northwest edge. The transverse folds have been produced by the forces that caused the large east-west fault three-quarters of a mile south of this mine. Where these transverse folds cross the strike folds there is a doming of the strata with quaquaversal dips. Such factors as these have a

direct bearing on the estimation of reserve ore tonnage and on the mining of the ore, and a good case is made for the advantages to be gained by frequent examinations of a working mine by a geologist familiar with its development, or in other words close cooperation between the mining engineer and the geologist. A forward look in the developments is shown in the suggestion that mining might be simplified by the driving of a deeper rock slope below the folds in the bed of ore.

The presence of "draw slate" or shale at the top of the ore bed has been mentioned in the section on page 105, where it was shown to be 1 ft. 2 in. thick, but in many places the thickness is as much as 1 ft. 8 in. Very careful mining is required to avoid pulling down this shale, and in fact it can not safely be left as it may fall and impede subsequent mining. It can not entirely be separated in the mine and more or less of this shale consequently finds its way into the ore as shipped to the blast furnace. Doctor Grasty shows in a series of samples that the grade of ore in the Attalla mine is relatively high but that due to inclusion of shale the grade of the ore that reached the furnace was distinctly lower. He therefore recommended picking belts, a provision that, as noted on page 105, had already been employed at the Citico mine.

A section of the ore bed in the west end of room 18 about 300 ft. from the bottom of slope No. 1 in the Attalla mine is detailed as follows by Doctor Grasty:

Section of iron ore bed at Attalla mine

	Ft.	In.
Shale		
Ore, hard		5½
Shale		⅛ to ¼
Ore, contains fossil crinoids at bottom		8
Ore, lower 9 in. softened by blasting	1	6

Dip 26° S. 15° E. Total ore, 2 ft. 7½ in.

The analysis of a sample of ore from this place is shown as No. 15, page 111.

Other measurements and samples by Doctor Grasty are as follows:

Location	Thickness Ft.	Thickness In.	Dip	Analysis No.
Slope 2, between rooms 3 and 5	3		25° SE.	16
Slope 2, room 10	3	11	22° SE.	17
Slope 2, room 22, 275 ft. SW. of slope	2	9		18
Slope 3, soft ore 150 ft. from entrance at outcrop	1	10	25° SE.	19
Northeast end of main haulway	1	8	22° SE.	20
Slope 1, west end room 12	2	10	25° S. 15° E.	21

In the following analyses there are inconsistencies between the composition of the hard ore as it occurs in the bed and as received at the furnace. The lower grade of the latter is probably the lower due to the inclusion of shale from the roof of the ore bed.

Analyses of iron ore of the Red Mountain formation from vicinity of Attalla

(Hard ore unless otherwise specified)

	Locality	Authority—a	Basis—b	Fe	SiO_2	Al_2O_3	H_2O	Insol.	CaO	Mn	P	Memoranda
1.	Moragne mine	M. II, 223		45.36	4.55	3.82		14.40	0.30	0.41	0.10	
2.	" " (soft)	M. II, 221		53.92	8.39					0.68		
3.	" "	C		36.97	8.61			16.56		0.50		
4.	" "	C		40.65	11.36	4.86		11.36	0.18	0.44		
5.	" "	GS	D	34.38	10.32	4.86		18.02			1.7	
6.	" "	"	D	34.66	9.00	5.04		18.32			2.1	
7.	" "	"	D	33.07	16.60	5.80		15.31			2.1	
8.	" "	"	D	30.47	14.92	6.94		14.86			2.2	
9.	" "	"	D	34.84	12.22	5.30		15.64			3.0	
10.	" "	"	D	37.03	9.28	4.17		17.00			2.5	
11.	" "	"	D	33.70	11.16	5.45		16.54			2.2	
12.	" "	"	D	31.51	13.24	5.49		16.28			2.4	
13.	" "	"	D	36.02	15.78	6.33		11.85			2.7	
14.	" "	"	D	35.15	8.96	5.04		17.97			2.6	
15.	" "	"		34.66	9.00	5.04		18.32			2.10	
16.	Attalla mine	"		38.48	9.62	4.91		15.42			1.70	
17.	" "	"	D	36.36	8.62	3.94		16.47			2.30	
18.	" "	"	D	36.73	11.60	5.74		13.27			3.00	
19.	" "	"	D	37.91	12.53	4.73		13.28			2.80	
20.	" "	"	D	39.30	8.81	4.75		13.73			5.00	
21.	" "	"	D	42.24	9.10	4.56		11.75			3.50	
22.	" "	"	D	40.55	8.12	4.18		13.00			2.20	
23.	" "	"	D	38.69	9.86	5.07		12.58			3.40	
24.	" "	"	D	39.62	8.80	4.63		13.83			5.00	
25.	" "	"	D	38.69	8.92	4.84		12.74			2.80	
26.	" "	"		34.71	8.38	3.66		17.61			3.30	
27.	" "	"		32.75	10.72	4.68		17.51			3.60	
28.	" "	"		38.31	9.82	4.84		15.51			2.50	
29.	" "	S	D	36.98	10.32	4.78		16.42				
30.	" "	S	D	36.57	8.80	4.55		17.04				
31.	" " (soft)	W		51.02	10.74	2.00		n.d.				
32.	" " "	W		52.56	7.16	n.d.		n.d.				
33.	" " "	W		51.90	8.40	n.d.		n.d.				
34.	"	W		52.75	8.76	n.d.		n.d.				

Analyses of iron ore of the Red Mountain formation from vicinity of Attalla

(Hard ore unless otherwise specified)

Locality	Authority—a	Basis—b	Fe	SiO_2	Al_2O_3	H_2O	Insol.	CaO	Mn	P	Memoranda
35. " " (hard)	W		43.88	9.26	n.d.		17.86				
36. " " "	W		38.05	8.40	n.d.		27.00				
37. Attalla	G	D	41.00	5.00	4.00		10.80c	0.54	0.43	3.40	
38. "	G	D	45.00	5.80	4.38		8.00	0.44	0.48	4.40	
39. "	G	D	43.00	6.70	4.30		10.70	0.44	0.48	4.40	
40. "	G	D	41.00	6.00	4.60		11.40	0.54	0.48	2.00	
41. " (soft)	G	D	53.80	5.00	3.40		3.40	0.44	0.74	2.80	
42. "	G	D	39.00	6.70	2.70		12.60	0.54	0.89	4.00	
43. "	G	D	40.00	5.70	5.00		10.80	0.52	0.48	4.00	
44. "	G		38.70			17.50	9.20		0.47		
45. "	G		41.20			13.63	8.48				
46. "	G		40.72			15.20	11.10		0.51		
47. "	G		36.30			19.50	10.45		0.51		
48. "	G		37.70			14.00	10.00				
49. "	G		46.00	9.90	4.53		11.60	0.72	0.41		
50. "	G		38.80	12.57	2.34		11.10	0.52	0.48		
51. "	G		38.90			14.66	11.16				
52. "	G		40.80	9.40	4.64		7.40	0.44	0.46		
53. "	N		38.98			13.81	15.25		0.46		
54. "	N		38.48		4.68	9.59	15.08	0.29	0.48		
55. "	S	D	41.56	7.92	4.15		13.03				
56. "	S	D	38.85	12.42	3.71		14.48				
57. "	S	D	39.88	9.42	3.76		14.60				
58. " Jan. 1926	SS		40.29	6.40	4.69	10.69			0.50		
59. " Feb. 1926	SS		40.40	7.50	4.55	11.74			0.47		
60. " Mar. 1926	SS		36.12	10.00	4.54	13.45	7.50				About 500 feet
61. " " 1926	SS		40.51	7.30	4.52	11.73	11.49		0.44		vertical depth
62. " Apr. 1926	SS		39.71	8.90	3.52	11.96	11.73		0.46		
63. " July 1926	SS		40.10			9.90	12.30				2 ft. 9 in. Room 46
64. " " 1926	SS		32.00			18.60	14.00				3 ft. Room 45
65. " " 1926	SS		32.80			9.60	18.48				3 ft. 1 in. Slope

a—Authorities: M. II, McCalley, Henry, Report on Valley Regions of Alabama, Part II, Geological Survey of Alabama, 1897; C. Citico Blast Furnace Co.; GS, Gulf States Steel Co.; S, Standard Steel Co.; W, Woodstock Iron Co.; G, J. S. Grasty, private report, 1913; N, W. A. Nelson, private report, 1916; SS, Sloss-Sheffield Steel and Iron Co.

b—Basis: D, dry; if blank, not reported.

c—Plus MgO, 0.72 per cent.

Crudup.—Northeast of Attalla for several miles the outcrop of the ore bed can easily be traced by the ore debris on the surface and from abandoned open cuts. At the higher points the ore bed is northwest of the crest of the ridge, but opposite the lower points the bed outcrops a short distance down on the southeast slope. For a few miles northeast of the Attalla mines, thicknesses of 1½ feet to 3 feet of ore have been reported, but none have been observed that reached that maximum. From a professional report by Wilbur A. Nelson made in March, 1916, the following five sections of the ore bed that crops out just southwest of Crudup are derived, reading from the southwest toward the northeast. The strike of the beds is N. 65° E. and their dip 24° to the southeast.

Sections of iron ore bed southwest of Crudup

	Ft.	In.
Top of seam		
Ore		2½
Shale		1½
Ore		3½
Ore and shale		1½
Shale		2
Ore		2
Shale		2
Ore		10
Bottom of seam		

Total ore, including a little shale, 1 ft. 7½ in.

	Ft.	In.
Top of seam		
Ore		4
Shale		2½
Ore	1	7
Bottom of seam		

Total ore, 1 ft. 11 in.

	Ft.	In.
Top of seam		
Ore		3
Shale		1
Ore	1	7½
Shale		5
Ore		8
Bottom of seam		

Total ore, 2 ft. 6½ in.

	Ft.	In.
Top of seam		
Ore		3
Shale		1½
Ore		2½
Shale		5½
Ore		7½
Ore, dirty		2½
Ore		9
Bottom of seam		

Total ore, 2 ft. ½ in.

	Ft.	In.
Top of seam		
Ore		7½
Shale		1
Ore		11½
Shale		4¾
Ore		11
Bottom of seam		

Total ore, 2 ft. 6 in.

The following section practically across the Red Mountain formation was measured by McCalley along the old road at "Broughton Bridge Gap," (Pl. 3, 3) about 5½ miles northeast of the "Low Gap" north of Attalla. It gives a thickness of about 606 feet, but it is not stated whether or not the measurements were corrected for dip, which in this vicinity is about 14° toward the southeast.

Section of Red Mountain formation along road over ridge in NE¼ of NE¼ of sec. 7 (?), T. 11 S., R. 6 E.

(M. II, p. 215)

	Ft.	In.
(14) Sandstones with some interstratified shales and loam, about	225	0
(13) Shale, ore; in alternate streaks		10
(12) Sandstone; very hard, called "cap rock" to ore		2
(11) Shale		2
(10) Ore		2
(9) Shale		2
(8) Ore	1	2
(7) Shales with interstratified sandstone, about	100	
(6) Ore; good and soft, outcrop about	3	
(5) Shale, sandstone; about	175	
(4) Shale, ore; the ore very sandy and in thin seams in shale	10	
(3) Loam; sandy, red, with loose shales, about	80	
(2) Loam, ore; the ore sandy and in loose pieces in red sandy loam, about	10	
(1) **Pelham (Trenton) limestones**		
Total	605	8

According to McCalley, to the northeast of "Broughton Bridge Gap" for about one-quarter mile the ore seam (8) of the above section was mined on the surface, and in four sections it ranged in thickness from 1 ft. 3 in. to 1 ft. 8 in. The soft ore (semihard?) contained about 42.5 per cent metallic iron and 10.5 per cent silica. This locality, which is 5 to 6 miles northeast of Attalla, corresponds to the southern part of the Crudup area where the ore bed is thicker underground and has yielded a considerable tonnage of ore. In 1905 ore mined here was shipped to the blast furnace at Trussville, Ala., and later to Alabama City (now Gadsden).

The mines at Crudup (Pl. 3, 3 and 4) were at the height of their activities in November, 1911. They were being operated by the Southern Iron and Steel Co., which later was merged into the Gulf States Steel Co., and the ore was used in the company's blast furnace and steel plant at Alabama City. The Gulf States Steel Company later was purchased by the Republic Steel Corporation.

The ore at Crudup is peculiar in that it incloses many thin seams and small lenticular masses of shale. (See Fig. 6B) The ore

bed appears to have been deposited in shallow water containing more or less mud and possibly to have been broken up in places by wave action so that angular fragments of the mud rock, or shale, have been incorporated into the ore material. The distance between floor and roof of the ore bed ranges between 4 and 5 feet, but the total ore in the section ranged from less than 2 ft. 6 in. to 5 ft. The following sections of the ore bed were measured within the Crudup mine, which consisted of at least 3 slopes driven southeastward down the dip of the ore bed, some open cuts, and drifts driven on the strike of the ore from ravines on the southeast slope of the ridge.

Section of iron ore bed in room 64, 750 ft. northeast of slope No. 1, Crudup Mine

	Ft.	In.
Shale		
Ore, with 2 or 3 streaks of shale aggregating 1 in. to 3 in. in thickness	4	7
Shale		

Dip 14° S. 65° E. Total ore generally 4 ft. 5 in.

Section of iron ore bed in room 66, 300 ft. northeast of slope 1, Crudup Mine

	Ft.	In.
Sandstone or "Jack Rock"		
"Draw slate," or shale		6-10
Ore		5½
Shale		1½-2
Ore, with a few shale kidneys	2	6
Shale		3
Ore, with many shale kidneys and limy streaks	1	1
Shale		

Dip 13° SE. Total ore, 4 ft.

Section of iron ore bed in room 72, 150 ft. northeast of slope 1, Crudup Mine

	Ft.	In.
Shale		
Ore	1	2
Shale		2
Ore		4
Shale		1
Ore	1	
Shale		

Dip 14° SE. Total ore, 2 ft. 6 in.

Section of iron ore bed in room 73, 100 feet southwest of slope 1, Crudup Mine

	Ft.	In.
Shale		
Ore and shale 1:1		2½
Ore		5
Shale		3
Ore, shaly		3
Shale		2
Ore, with a little shale		7
Shale		1½
Ore, limy in places	1	1½
Shale		

Dip 16° SE. Total ore, 2 ft. 5 in.

Section of iron ore bed in main S. heading about 300 ft. southwest of main entry, Crudup Mine

	Ft.	In.
Shale		
Ore		6-7
Shale		1½
Ore		4
Shale		1
Ore	2	2
Shale		2
Ore	1	6
Ore, shaly, not mined		5
Shale		

Total ore mined, 4 ft. 6 in. to 4 ft. 7 in.

This was the famous 5-foot thickness of ore in this mine. At this point an incline is driven to the outcrop and also a level is cut across to a lower bed of ore.

Section of iron ore bed in room 31, 150 ft. northeast of slope 3, Crudup Mine

	Ft.	In.
Shale		
Draw slate		3
Ore		4
Shale		½
Ore, a few shale streaks	1	7
Shale		6
Shale and ore 1:1		4
Ore		3
Shale, a little ore		4
Ore		1
Shale		¼
Ore		1
Shale		½
Ore		2
Shale		2
Ore		3
Shale		2
Ore		1
Shale		

Dip 15° to 16° SE. Total ore, 3 ft.

Section of iron ore bed in room 37, 125 ft. northeast of slope 3, Crudup Mine

	Ft.	In.
Shale		
Ore, very limy with some kidney shale	1	5
Shale		4
Ore		0- ½
Shale		0- ½
Ore		2
Shale and ore		2
Ore		2
Shale		½
Ore		½
Shale		1
Ore		6
Shale		2
Ore		2
Shale		3½
Ore		2
Shale		2
Ore		4
Shale		

Dip 16° SE. Total ore, 3 ft.

Section of iron ore bed in room 26, 200 ft. southwest of slope 3, Crudup Mine

	Ft.	In.
Shale		
Ore, with shale streaks and kidneys and considerable lime	1	6
Shale, with streaks of ore at bottom		5½
Ore		4
Ore and shale, 1:1 alternating in streaks ½ to 1 in. thick	1	5
Ore, soft		6½-7
Shale		

Dip 14° to 15° SE. Total ore, about 3 ft.

Section of iron ore bed in room 11, just south of incline, Crudup Mine

	Ft.	In.
Shale		
Ore	1	7
Shale		5½
Ore, limy		2½
Shale		¾
Ore		7
Shale		3
Ore and shale 1:1 alternating in streaks about 3 in. thick	1	1
Shale		

Dip 16° SE. Total ore, about 2 ft. 11 in.

Section of iron ore bed in room 1, just south of incline, Crudup Mine

	Ft.	In.
Shale		
Ore		1¼
Shale		1-1½
Ore	1	5
Shale, with a little ore		3
Ore and shale, 1:1		3½
Ore		7½
Shale, with a little ore		7
Ore, with a few streaks of shale	1	1
Shale		

Dip 17½° S. 65° E. Total ore, about 3 ft. 4 in.

Section of iron ore bed in N. 4 opening, 1½ miles northeast of S. Crudup Mine, driven 150 feet on strike from a side valley

	Ft.	In.
Shale		
Ore, solid, granular		10
Shale	1	10
Ore, solid	1	3
Shale		

Total ore, 2 ft. 1 in.

Section of bottom iron ore bed 1,000 ft. below ore outcrop at old N. 1 slope, Crudup Mine

	Ft.	In.
Shale, hard		
Ore, fossiliferous, a few kidneys of shale	1	6
Ore, very limy		8

(At outcrop shows 2 ft. 7 in. practically clean ore)
Total ore, 2 ft. 2 in.

A summary of ore measurements during operations in 1911 were as follows: The bed in Slope No. 1 ranged in thickness from 33 inches to 35.88 inches, with a general average of 33.86 inches or 2 ft. 9.86 in.; No. 2, from 27.2 inches to 30.7 inches, with a general average of 3 ft. 5.64 in.; and No. 3, from 20.3 inches to 31 inches, with a general average of 25.96 inches or 2 ft. 1.96 in. In April, 1911, the lengths of the slopes at Crudup mines were reported as follows: No. 1, 796 ft.; No. 2, 920 ft.; No. 3, 748 ft. As the slopes were worked deeper toward the southeast the ore thinned and deteriorated. It was thought that the ore might become of better quality and thickness farther southeast, below the valley of Little Wills Creek, therefore five holes were drilled southeast of the Crudup mines. One of these drill holes, bored at a distance of 3050 feet southeast of No. 1 slope with a 1 1/8 inch diamond core drill is reported to have shown the following section which indicates an increase in thickness of several inches as compared with the thickness at the outcrop of the bed:

Section in drill hole 3050 ft. southeast of No. 1 slope, Crudup Mine

	Thickness Ft.	In.	Depth Ft.	In.
Shale	391	6	391	6
Ore	1			
Shale and ore	1			
Ore		4½		
Shale with granules of ore		2½		
Ore with ½ in. shale parting	2	6		
Shale			396	7

Dip 5° to 7° SE. Total ore, 3 ft. 10 in.

A drill hole 4,000 feet southeast of the slope at North Crudup is reported to have shown only 4 inches of ore, a hole southeast of the South Crudup slope is reported to have shown very lean and thin ore, and three holes in the valley near the Alabama Great Southern Railway are reported to have shown nothing encouraging. Mining was therefore discontinued in 1912. The ore deposit near Crudup is apparently a good example of a lens-shaped body that thins out in various directions.

The Crudup mines were re-visited in 1941. Mining had not been resumed, and the machinery had been sold for scrap.

The following analyses indicate the character of the soft and hard ore mined at Crudup:

Analyses of iron ore from Crudup mines and drill holes

(Hard ore unless otherwise specified)

Locality and Type	Authority—a	Basis—b	Fe	SiO_2	Al_2O_3	CaO	Mn	P	H_2O	Memoranda
Crudup (soft)	S		48.31	14.76	5.60	2.12				
" "	S		48.80	18.06	5.19	1.12			2.00	
" "	GS	D	56.98	9.02	4.93	1.28	.11	.48		
"	S		36.88	10.87	4.55	16.30				
"	S		46.67	6.04	3.03	11.28			.40	
N. Crudup	S	D	32.82	9.92	4.28	20.06			2.40	
So. Crudup	S	D	34.98	14.28	5.55	15.24			2.60	
N. Crudup	S	D	34.87	10.80	4.51	18.26			1.40	
So. Crudup	S	D	35.91	14.36	5.61	14.92			1.60	
N. Crudup	S	D	33.41	10.26	4.38	19.88			1.60	
So. Crudup	S	D	35.29	14.14	5.52	15.16			2.70	
N. Crudup	S	D	32.36	10.14	4.12	19.78			1.50	
So. Crudup	S	D	35.60	14.58	5.37	14.91			2.00	
Crudup	GS	D	16.28	5.83	2.11	37.21	.15	.10		
"	GS	D	7.11	2.89	.93	47.11	.18	.08		Drill
"	GS	D	15.44	4.92	1.60	38.56	.19	.21		Core
"	GS	D	30.66	7.19	3.13	24.02	.14	.28		
"	GS	D	40.18	11.20	3.86	13.46	.19	.40	1.20	
"	GS	D	41.34	6.26	3.12	16.38		.41	.90	
"	GS	D	38.88	9.48	3.71	15.84		.42	1.50	
"	GS	D	37.29	10.70	4.09	16.84	.12	.38		
N. Crudup	GS	D	39.27	8.80	3.68	16.17				
So. Crudup	GS	D	36.54	10.26	3.72	17.60				
N. Crudup	GS	D	38.44	9.29	3.87	17.01				
So. Crudup	GS	D	40.47	12.04	5.00	12.88				
" "	GS	D	35.14	13.06	4.70	16.09				
" "	GS	D	35.98	13.96	4.98	15.71				
" "	GS	D	36.61	12.97	5.01	15.37				
" "	GS	D	35.70	13.58	4.91	15.42				
" "	GS	D	36.82	13.09	5.21	14.98				
" "	GS	D	35.35	13.88	5.36	15.78				
N. Crudup	GS	D	32.91	10.96	4.15	19.62			1.20	
So. Crudup	GS	D	34.27	14.78	5.86	14.92				

Analyses of iron ore from Crudup mines and drill holes

(Hard ore unless otherwise specified)

Locality and Type	Authority—a	Basis—b	Fe	SiO_2	Al_2O_3	CaO	Mn	P	H_2O	Memoranda
N. Crudup	GS		25.54	5.88	2.54	30.07	.11	.28		
" "	GS		22.15	6.12	2.76	31.94	.10	.24		
" "	GS		1.65	4.48	1.85	50.29				Drill
" "	GS		11.12	3.16	2.04	43.23	.06	.13		Core
" "	GS		17.72	3.31	2.12	37.96	.08	.20		
" "	GS		1.65	3.86	1.67	50.62				
Crudup	GS		18.07	36.28	12.46	8.45				
"	GS		26.53	23.24	8.08	13.53				
"	GS		36.54	10.35	4.23	17.28				
"	GS		21.31	32.04	11.12	9.55				
"	GS	W	38.26	15.40	6.03	11.63			.50	
"	GS	W	16.23	38.88	13.39	7.44			.80	
"	GS	W	35.88	16.12	6.95	11.23			.50	Drill
"	GS	W	18.82	34.44	11.30	10.08			.70	Cores
"	GS	W	42.19	13.48	5.52	9.98			.60	
"	GS	W	47.05	11.00	4.27	8.32			.70	
"	GS	W	16.44	36.52	12.72	9.67			.80	
"	GS	W	19.65	32.18	12.22	10.75			.90	
"	GS	W	36.60	15.12	5.94	12.72			1.00	
N. Crudup	S		38.14	9.29	3.87	17.01				
Crudup	S		35.80	13.84	5.07	15.34				
c—So. Crudup	US		29.51	27.67	10.39	5.93	.03	.37		K_2O, 2.56

a—Authorities: S, Standard Steel Co. or Southern Iron & Steel Co.; GS, Gulf States Steel Co.; US, U. S. Geological Survey.

b—Basis: D, dry; W, wet; if blank, not reported.

c—Average for January, 1912.

Comparison of the analyses of Crudup ore with those of other ores shows that the alumina is somewhat higher in the Crudup ore. This is due to the abundant inclusions of shale within the ore that are peculiar to the Red Mountain ore in this locality. During the World War there was a shortage of potash in the United States and the recovery of potash salts as a byproduct from blast furnace gases was advocated by several engineers. The abnormally high proportion of shale in the Crudup iron ore suggested to the senior author that this ore should yield more than the normal quantity of potash in the blast furnace and therefore might be of much importance if blast furnace operators actually undertook the recovery of potash.[1] A specimen of the lean, shaly hard ore from Crudup was acordingly analyzed in the laboratory of the United States Geological Survey and showed 2.56 per cent of potash (K_2O) which indicated that this ore might under emergency conditions yield potash as a byproduct in the blast furnace. In addition to the other constituents indicated there was found 0.62 per cent of titanium oxide.

One and one-half miles northeast of Crudup (Pl. 3, 5) the following section of the ore was measured near the top of the ridge in a small mine tunnel driven by the Southern Iron and Steel Company then operating the Crudup mines:

Section of iron ore bed 1½ miles northeast of Crudup

	Ft.	In.
Shale		
Ore, soft, good	1	
Shale parting	2	3
Ore, good	1	3
Shale		

Dip 15° to 20° SE. Total ore, 2 ft. 3 in.

About 2½ to 3 miles northeast of Crudup, or within the Fort Payne quadrangle (Pl. 4, 1), a bed of soft ore measuring 1 ft. 2 in. thick crops out on the northwest side of the crest of the ridge. The ore is granular and fossiliferous and is reported to contain about 56 per cent of metallic iron. The bed dips 15° to 20° SE., and probably lies near the surface on the southeast slope of the ridge and in the valley. This indicates the possibility of a good

[1]Burchard, Ernest F., Potash as a byproduct in the cement and iron industries: Manufacturers Record, Sept. 14, 1916, pp. 73-75.

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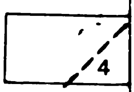

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Middle section:

Shale, "draw slate"	6
Shale and ore mixed	3½
Ore	5
Shale	2
Ore	6
Shale	2½
Ore	1½
Shale	2
Ore	4½
Shale	3
Ore	9½

Dip 15° to 16° SE. Total ore, about 2 ft. 4 in.

Upper section:

Shale, "draw slate"	6
Shale and ore mixed	9
Ore and shale	6½
Shale	1
Ore and shale	6
Shale	3
Ore	11½

Dip 15° to 16° SE. Total ore, about 1 ft. 10 in.

The next section was measured during the Survey work.

Section of iron ore bed near Keener in tunnel driven about 100 *ft. in hill*

	Ft.	In.
Sandstone		
Shale, "draw slate"		6
Ore and shale		3½
Ore		5
Shale		2
Ore		6
Shale		2½
Ore		1½
Shale		2
Ore		4½
Shale		3
Ore		9½
Shale		

Dip about 22° SE. Total ore, about 2 ft. 4 in.

The following six analyses show the nature of the hard and soft ore near Keener. The hard ore was sampled in the tunnel, the section of which is given above.

Analyses of iron ore from near Keener

(Hard ore unless otherwise specified)

Locality	Authority—a	Fe	SiO_2	Al_2O_3	CaO	Mn	P
1. Keener	S	25.60	12.50	5.35	22.43	.26	.35
2. Keener (soft)	S	48.96	14.80	6.78	Tr.	.44	.55
3. Keener (semihard)	S	46.48	4.92	4.02	12.09	.19	.47
4. Keener	GS	33.51	10.36	5.30	17.23		
5. Keener	GS	35.25	14.88	8.12	10.56		
6. Keener (soft)	GS	47.32	17.40	8.04	0.96		

a—Authorities: S, Standard Steel Co.; GS, Gulf States Steel Co.

The outcrop of iron ore in the SE¼ of sec. 14, T. 10 S., R. 6 E., and vicinity was examined professionally by Wilbur A. Nelson in March, 1916. This is near the head of Taylor Branch Hollow, about 1¼ to 1½ miles west of Keener and is probably near Locality 3. Plate 4. The rocks were found to dip from 10° to 18° SE. with an average of about 13½°. The soft ore had been worked on the outcrop and a considerable tonnage removed, but in general it appeared to contain shale partings.

Two holes were drilled through the ore bed in Taylor Branch Hollow with rather disappointing results. Hole No. 1 was drilled 1630 ft. from the ore outcrop and reached the ore bed at a depth of about 300 feet. If a graphic correction for the average dip of 13½° to the southeast, and deduction for the vertical thickness of 4 feet of surface material and 24 feet of Chattanooga (?) shale be made the ore bed lies stratigraphically about 264 feet below the base of the shale. The section of Hole No. 1 follows:

Record of drill-hole No. 1 in Taylor Branch Hollow, west of Keener

		Thickness		Depth	
		Ft.	In.	Ft.	In.
	Surface	4	0	4	0
	Black slate (probably Chattanooga shale)	24	0	28	0
	Dark greenish sandstone	41	0	69	0
	Greenish sandy slate	110	0	179	0
	Sandstone	50	0	229	0
	Sandstone with fossils	35	0	264	0
	Green slate with sand streaks	34	0	298	0
	Fossiliferous gray slate	0	½	298	½
	Dark slate	0	1¼	298	1¾
	Fossiliferous limestone and slate, red	0	¾	298	2½
	Dark gray slate fossils in streaks	0	2¼	298	4¾
	Fossiliferous red limestone	0	3	298	7¾
	Dark gray slate	0	3¾	298	11½
	Fossiliferous red limestone	0	2¼	299	1¾
	Dark gray slate	0	8	299	9¾
	Limey gray slate	0	1	299	10¾
	Dark gray slate	0	4½	300	3¼
	Fossiliferous limestone and red slate	0	2	300	5¼
	Fossiliferous limestone and gray slate	0	1¼	300	6½
	Red slate	0	¾	300	7¼
	Fossiliferous ore, poor quality	0	1¼	300	8½
	Gray slate	0	1¼	300	9¾
	Iron ore good	0	6½	301	4¼
Ore bed	Slate	0	¼	301	4½
	Fossiliferous ore, poor	0	1¼	301	5¾
	Dark gray slate	0	3	301	8¾
	Fossiliferous siliceous ore, poor	1	½	302	9¼
	Slate with sand streaks	16	5¾	319	3
	Sandstone	5	8	325	0
	Slate with sand streaks	24	0	349	0
	Dark sand and slate	10	0	359	0
	Dark sandstone	2	0	361	0
	Dark sand slate	10	0	371	0
	Conglomerate	1	0	372	0
	Dark sandstone	6	0	378	0
	Conglomerate	0	6	378	6
	Dark sand slate	21	6	400	0
	Total depth—400 feet.				

According to this record the ore, including poor portions, was about 1 ft. 9½ in. thick.

The second hole was drilled at a distance of 575 ft. from the outcrop of the ore and reached the bed at a depth of 103 ft.

Record of drill hole No. 2 in Taylor Branch Hollow, west of Keener

		Thickness		Depth	
		Ft.	In.	Ft.	In.
	Surface	6	0	0	0
	Sandstone	0	6	6	6
	Dark sandy slate soft	5	0	11	6
	Light close-grained sandstone	27	0	38	6
	Brown sandstone	3	6	42	0
	Light sandstone	1	0	43	0
	Dark slate	20	6	63	6
	Sandstone	1	0	64	6
	Dark slate	1	2	65	8
	Sandstone	0	6	66	2
	Dark slate sand streaks	34	0	100	2
	Sandstone slate streaks	3	0	103	2
	Slaty ore streaks of lime	0	2¾	103	4¾
	Limey ore	0	2¼	103	7
	Lime and slate streaks	0	1¼	103	8¼
	Limey ore	0	¾	103	9
	Fossiliferous ore	0	2½	103	11½
	Slaty ore	0	½	104	0
	Slate	0	4¼	104	4¼
	Slaty ore	0	1¼	104	5½
	Ore	0	3	104	8½
Ore	Fossiliferous ore	0	1	104	9½
bed	Lime and slate	0	1¾	104	11¼
	Slaty ore	0	1	105	¼
	Poor ore	0	1¾	105	2
	Slaty ore	0	3¼	105	5¼
	Slaty ore and lime streaks	0	¾	105	6
	Slaty ore	0	4¼	105	10¼
	Ore	0	½	105	11
	Slate	0	½	105	11½
	Ore	0	6½	106	6
	Slate	0	1¾	106	7¾
	Ore	0	3¼	106	11
	Sandy slate	13	1	120	0

Total depth of hole, 120 feet.

This record shows a total of 2 ft. 11¼ in. of ore including more than 50 per cent of "limy," "slaty," and "poor" ore.

On the ridge northwest of Keener at the mouth of a prospect tunnel the following section was noted by J. R. Ryan:

Section of iron ore bed 1 mile northwest of Keener

	Ft.	In.
Shale		
Ore, soft, good		3
Shale		2
Ore		2
Shale		6
Ore, mixed with shale	1	3
Ore, good	1	3
Shale		

Dip 12° to 15° SE. Total ore, about 2 ft. 3 in.

In the gap of the ridge northwest of Keener through which the highway to Big Wills Valley passes some extensive strip-pit workings were seen just southwest of the road. (Pl. 4, 4) The ore is reported to have been mined here for the manufacture of metallic paint. The old workings were somewhat filled with talus and a thickness of only about 1 ft. 2 in. of ore was visible but the maximum is probably greater and the thickness was locally reported at 2 ft. The bed dips about 11° toward the southeast and had been mined only where the ore was soft, as that form of the ore is best for paint manufacture. The hard ore seems to have been reached within short distances at the sides of the ravines.

On the road down the west slope of the ridge here there is a good exposure of the ferruginous limestone beds of the Chickamauga limestone overlain unconformably by ferruginous shaly sandstone beds of the Red Mountain formation.

The ore becomes thinner toward the northeast as shown by the following section measured on the west side of Red Mountain about 1½ miles north of Keener (Pl. 4, 5):

Section of iron ore bed 1½ miles northwest of Keener on the West side of the ridge

	Ft.	In.
Shale		
Ore, semi-hard		9
Shale		4
Ore		7
Shale		

Dip 20° to 25° SE. Total ore, 1 ft. 4 in.

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Section of iron ore bed 1 mile northwest of Keener

	Ft.	In.
Shale		
Ore, soft, good		3
Shale		2
Ore		2
Shale		6
Ore, mixed with shale	1	3
Ore, good	1	3
Shale		

Dip 12° to 15° SE. Total ore, about 2 ft. 3 in.

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	Ft.	In.
Shale		
Ore, semi-hard		9
Shale		4
Ore		7
Shale		

Dip 20° to 25° SE. Total ore, 1 ft. 4 in.

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Farther northeast, at the northeast side of the road that crosses Red Mountain about 3 miles north of Keener the ore is mixed with shale nearly across the bed, as shown in the next section (Pl. 4, 6):

Section of iron ore bed 3 miles north of Keener, Ala.

	Ft.	In.
Shale		
Ore, soft, dirty		2
Ore, good		7
Ore, mixed with shale		6
Shale		2
Ore, mixed with shale		11
Shale		

Dip about 15° SE. Total ore, mostly shaly, about 2 ft. 2 in.

A similar section was noted by J. R. Ryan about 2 miles northeast of the last section, (Pl. 5, 1), and about 1 1/3 miles northeast of that section he noted in a prospect tunnel at the side of a small creek south of the road which crosses the ridge about 4 miles N. NE. of Keener a bed showing a greater total thickness but consisting of shale and ore so intimately mixed that the material is of no value. The dip is about 15° SE. This locality (Pl. 5, 2) is in DeKalb County, about 5 miles southwest of Collinsville.

McCalley (II, pp. 164-165) gives partial sections of the Red Mountain formation in the W½ of NW¼ sec. 28, T. 9 S., R. 7 E., and in the center of sec. 21, T. 9 S., R. 7 E., or respectively 3½ and 2½ miles southwest of Collinsville in which several seams of ferruginous rock are present, ranging from 2 inches to 2 ft. 6 in. in thickness, and there appeared to be some good soft ore present.

Collinsville.—In the gap of Red Mountain (Pl. 5, 3) one-half mile northwest of Collinsville the ore bed is exposed by erosion and by several prospect drifts. Its range in thickness is from 1 ft. 5 in. to 2 ft. The ore is hard, granular, calcareous, and fossiliferous (many specimens of the coral, **Streptelasma** present), and contains considerable argillaceous material in small hard masses. The ore varies in quality as well as in thickness. On the outcrop at the creek it has a thickness of 1 ft. 7 in., and might average

28 per cent iron. In the first prospect above the creek the minimum and maximum thicknesses are shown, but masses of barren material are present. One prospect consisted of a drift 50 feet long, and another on the opposite side of the creek followed the ore for about 75 feet on the strike. At the breast of this drift the following section was measured:

Section of iron ore bed in prospect drift ½ mile northwest of Collinsville

	Ft.	In.
Shale		
Ore		3
Shale		½
Ore, hard, lean	1	7
Shale		

Dip 12° S. 50° E. Total ore, 1 ft. 10 in.

Several other prospects had been made along the ridge for 3 miles or more to the southwest of Collinsville, but the hard ore generally appears to be too lean and too thin in this locality for exploitation.

North of Collinsville soft ore has been mined at several places by stripping along the outcrop. McCalley mentions two seams each about 12 inches in thickness of good soft ore having been surface dug to a considerable extent just northeast of the gap. At about 2½ miles north of Collinsville two seams of ore were noted about 15 feet apart. (Pl. 5, 4.) The upper bed, which consisted of two benches parted by 3 feet of shale, showed in a prospect at the head of a hollow on the southeast slope near the crest of Red Mountain the following section:

Section of iron ore bed 2½ miles north of Collinsville

	Ft.	In.
Shale		
Ore, fossiliferous, semi-hard to hard, fairly rich	1	4
Shale, hard and ferruginous in places	3	1
Ore, not quite as high grade as the top bench, but would be workable	2	
Shale		

Dip 8½° S., 55° E. Total ore, 3 ft. 4 in.

On the dump, where there were 15 to 20 tons of weathered material, the ore is coarsely granular and fossiliferous and con-

tains a little argillaceous material. The fossils consisted of characteristic corals, crinoids, and brachiopods.

The ore bed which outcrops about 15 feet lower, stratigraphically, measured about 1 ft. 6 in. thick. The material is apparently a little more siliceous and argillaceous than that in the upper bed and probably would be of value only locally on the outcrop. Whatever shipments of ore were made in former years probably came from the upper bench of the upper bed, which is reported to be from 1 ft. 6 in. to 2 ft. thick in places.

Portersville.—From the last-mentioned locality, which is about 2¼ miles southwest of Portersville, the ore bed improves slightly along the strike toward the northeast, the upper bench thickening slightly and the shale parting becoming thinner. The outcrop is northwest of the crest of the ridge. When visited by McCalley (M. II, pp. 159-161) there were extensive soft ore diggings on both sides of the Portersville Gap, (Pl. 5, 5) the workable thickness being 2 to 3 ft. of ore in two benches. The soft ore carried 47 per cent metallic iron. In 1905 the Southern Steel Co. was operating a mine on both sides of the gap in Red Mountain three-quarters of a mile northwest of Portersville. The mining was mainly northeast of the gap and consisted of strip trenches up the dip to the northwest parallel to the gap and an underground slope. At that time the slope extended S. 65° E. 400 feet on the ore bed which showed the following sections.[1]

Section of iron ore bed in mine slope at Portersville

	Ft.	In.
Ore	2	
Shale	1 0 to 1 6	
Ore	2	

Dip 15° SE. Total ore, 4 ft.

On the south side of the gap at a point where about 30 feet of overlying shale had been stripped off the ore bed showed the following sections:

[1]Eckel, E. C., U. S. Geol. Survey Bull. 285, pp. 176-177.

Sections of iron ore bed on south side of gap at Portersville

	(1) Ft.	(1) In.	(2) Ft.	(2) In.
Shale				
Ore	1	8	1	11
Shale	1	2		8
Ore	1	5	1	8

Total ore, 3 ft. 1 in. to 3 ft. 7 in.

A lower ore seam, not mined, averaging about 1 foot in thickness, cropped out in the road about 50 feet stratigraphically below the mined bed.

The hard ore as mined at Portersville contained generally between 25 per cent and 33 per cent metallic iron, 24 and 30 per cent calcium oxide and about 6 per cent silica plus alumina. (See analyses, page 127.) These mines, which formerly shipped ore to furnaces at Alabama City, have not been operated since 1909, and the railroad spur from the Alabama Great Southern Railroad at Portersville has been removed.

In 1928 most of the workings at this locality had then been abandoned for so long that little could be seen of the ore bed. The old slope was filled nearly to the roof with caved-down shale, but an old drift extending N. 20° E., showed 1 ft. 10 in. of hard, somewhat argillaceous ore underlain by shale, the base of which was concealed and probably represented the shale parting shown in the above sections. The beds dip about 12° S. 45° E. Much of the ore debris is of an argillaceous type as at the Crudup mines. The following analyses are representative of a large number of carloads of Portersville hard ore.

Analyses of Portersville hard and soft iron ores

Authority—a	Fe	SiO_2	Al_2O_3	CaO	Mn	P
E	33.05	5.56		25.20		n.d.
E	33.72	4.94		22.90		n.d.
E	25.52	5.60		30.82		n.d.
E	38.00	9.18		19.04		n.d.
E	30.35	6.42		25.88		n.d.
E	31.20	7.86		23.71		n.d.
E	31.95	5.80		26.62		n.d.
E	32.00	5.02		24.22		n.d.
E	31.98	6.29		24.80		....
GS	32.78	5.18	3.70	21.72		0.38
GS	34.45	6.98	4.22	19.35		0.32
GS	31.32	7.14	3.32	22.82		0.38
GS	30.78	6.12	3.04	24.18		0.37
S	28.45	9.12	4.10	22.40		0.31
S	36.00	5.18	3.68	21.12		0.40
S	32.94	5.28	3.87	22.47		0.29
T, d	45.60	16.70	8.20	1.65	0.27	0.497
T, n	39.67	14.52	7.13	1.20	0.23	0.432

a—Authorities: E, Eckel, Edwin C., The Clinton or red ores of northern Alabama: U. S. Geological Survey Bulletin 285, p. 177, 1905; GS, Gulf States Steel Co.; S, Standard Steel Co.; T, J. P. Todd, soft ore; d, dried; n, natural.

The old Portersville mines were visited by the two authors in June, 1941. At the north side of the road through the gap in Red Mountain an old adit driven north-northeast on the strike of the beds with slopes turned off down the dip of about 14° SE showed one bed of ore about 1 foot, 11 inches thick with shale below. The shale may have been the parting in the main seam but this is uncertain because caved-down debris obscured the base of the seam. On the mine dumps were slabs of fossiliferous limestone grading through ferruginous material into hard ore. Some of the ferruginous limestone contains greenish grains resembling glauconite. In the same kind of rock are many small vugs which contain small crystals of specular hematite and powdery material of similar character is present on freshly broken surfaces of the rock. The old mine dumps indicated that much ore had been wasted because of the high proportion of shale in seams and blebs within the ore bed that had to be discarded. Modern methods of concentration might prove useful on this type of ore.

Collbran.—From the gap near Portersville, Red Mountain maintains an unbroken ridge northeastward for about 5 miles, or to Killian Gap, about 1¼ miles northwest of Collbran. The crest of the ridge is capped by Fort Payne chert, and the Chattanooga

shale crops out about 45 feet below the crest west of Collbran so that beds of the Red Mountain formation make up a large part of the steep northwest slope of the ridge. There are not many good natural exposures of the ore bed in this area but some prospecting has been done within the half mile southwest of Killian Gap and in the gap itself. (Pl. 6, 1) Eight such prospects, made where the ore was semi-hard were examined by E. C. Eckel[1] who reports thicknesses of from 3 ft. 3 in. to about 4 ft., and averaging about 3 ft. 6 in. in thickness. An analysis of a general sample accompanying this report gives the following constituents:

Analysis of iron ore from near Collbran

	Percent
Iron (Fe)	39.80
Silica (SiO_2)	8.39
Lime (CaO)	11.67
Phosphorus (P)	0.45
Sulphur (S)	0.03

Other figures showed a range in iron of from 32.14 per cent to 55.31 per cent (the latter from the outcrop and evidently soft ore) but the majority of samples ranged between 35 and 39 per cent of iron.

The only detailed section given in this private report is as follows:

Section of iron ore bed near Collbran

	Ft.	In.
Top		
Ore		3
Shale		2
Ore, clayey	1	
Ore, high grade	1	4
Shale		3
Ore	1	

Total ore, including clayey seam, 3 ft. 7 in.

[1]Professional report to owners of property, 1912.

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Sections at "Baxter" iron ore beds in NE¼ SE¼ sec. 27, T. 7 S., R. 8 E.
(M. II, p. 157)

	Ft.	In.
Shale		
Ore, limy; merely a red clayey streak in places		5
Shale		4
Ore, good, limy	1	

	Ft.	In.
Shale		
Ore		2-6
Shale		3-4
Ore	1	

The following analyses show the composition of the ore from Killian Gap. The first six analyses are from the bed on the south side and the last six analyses are of ore from the north side of the gap.

Analyses of red iron ore from Killian Gap[1]

(Dry basis, percentages)

Ore	Fe	SiO_2	Al_2O_3	CaO
Siliceous	25.85	29.09	18.84	1.77
Siliceous	18.63	40.33	17.74	1.61
Siliceous	20.64	39.87	16.66	1.42
Semihard, Siliceous	43.32	22.33	8.66	1.25
Soft	53.68	9.23	6.02	1.96
Soft	55.15	9.30	6.14	.56
Hard	7.65	9.15	2.43	41.16
Hard	21.68	21.83	8.16	19.50
Hard	29.77	4.05	2.38	26.38
Hard	32.05	5.68	3.39	31.64
Semihard	35.69	5.98	3.50	19.55
Soft	55.55	7.37	6.01	1.21

About 3 miles southwest of Fort Payne the following succession of beds was noted by McCalley:

[1]Authority, Standard Steel Company.

Section of iron-bearing beds in NW¼ NW¼ sec. 24, T. 7 S., R. 8 E.
(M. II, p. 156)

	Ft.	In.
Shale; of dark color, visible	3	
Ore; hard and limy, variable in thickness and composition	1	3
Shale, ore; the ore in streaks in the shale	1	7
Ore; hard and limy		7
Shale; dark color	1	2
Ore, shale; in places an ore, in other places a shale		2
Shale; variable in thickness, of dark color	1	2
Ore, limy, variable in thickness and composition		5-7
Shale		2-6
Ore; limy and variable in composition	1	3

(Total ore about 3 ft. 7 in.)

The next gap in Red Mountain is about 2 1/5 miles northeast of Killian Gap and about 2½ miles southwest of the middle of the town of Fort Payne. Through this gap the main highway passes from Big Wills Valley to Fort Payne and here the Red Mountain formation is well exposed. The ferruginous, sandy limestone beds of the Chickamauga limestone are present here below the Red Mountain formation and contain a ferruginous ledge locally known as the "big sandy" iron ore bed, although it is not a commercial grade of ore. Northeast of this gap, about one-fifth mile from the road a prospect cut near the head of a small hollow in the west slope of the ridge shows the following section (Pl. 6, 2):

Section of iron ore bed in gap 2½ miles southwest of Fort Payne

	Ft.	In.
Shale		
Ore, hard, limy, lean	0 to 1	11 to 4
Shale	1	6
Ore, hard, limy, very lean		7
Shale	2	4
Limestone, ferruginous		10
Shale (base of pit concealed)		

Dip 20° S. 65° to 70° E. Total ore, maximum, 1 ft. 11 in., mostly lean and limy, although there were some lumps of fair quality ore on the dump.

The relation between the dip of the beds and the slope of the ridge precludes the probability of there being a large quantity of soft ore here.

Fort Payne.—From the gap last described northeastward to the gap just southwest of Fort Payne there is a stretch of Red Mountain about 1.65 miles long. The Red Mountain formation occupies the crest and parts of the northwest and southeast slopes of the ridge here, but the ferruginous portion is northwest of the crest of the ridge. (See Fig. 9). One-half mile south of the Fort Payne gap are a number of prospects made in the 1890's by the Fort Payne Fuel and Iron Co. (Pl. 6, 3) From the rocks exposed here, which include four ferruginous beds, the following generalized section has been constructed:

Generalized section of Red Mountain beds south of Fort Payne

	Ft.	In.
Sandstone and shale		
Top "ore seam":		
Upper bench partly concealed and shows only soft, shaly, ferruginous material. Lower bench showed solid blocks of hard ore containing **Pentamerus**	1	5
Shale, about	15	
"Red ore seam":		
Ferruginous sandy rock	0	4
Shale	4	0
Ore, hard limy, argillaceous, contains fossil **Streptelasma** (base concealed)	0	8
Shale and sandstone	100	
"Sandy ore seam," sandy ferruginous rock, not an ore	5	
Shale	15	
"Gray ore seam," chocolate colored ferruginous limestone	10	
Shale		
Total thickness of ferruginous series	151	5

Evidently the only seam that might yield ore, and that only on the outcrop, is the lower bench of the top bed.

The general character of the Red Mountain formation at Fort Payne is indicated in the following section of a bored well

Fig. 9. Northwest escarpment of Lookout Mountain facing Little Wills Valley with Red Mountain separating Little Wills and Big Wills Valleys. Red Mountain extends in an almost straight line from Valley Head 10 miles southwestward to Fort Payne.

at blast furnace No. 1 which formerly stood on the northwest side of Little Wills Valley about 1 mile southwest of Fort Payne, as report by McCalley, (M. II, p. 154) but revised as to formation names:

Section of well at Fort Payne Furnace No. 1.

	Thickness Ft.	Depth Ft.
Soil	25	25
Fort Payne chert	190	25-215
Chattanooga shale	12	215-227
Red Mountain formation:		
Shale, green and gray	340	227-567
Limestone, shale, and seams of limy ore	18	567-585
Shale with seams of ore	50	585-635
Shale, limestone, and sandstone	180	635-815
Sandstone, coarse, ferruginous	50	815-865
Sandstone and shale	40	865-905
Chickamauga limestone		905

The total thickness of the Red Mountain formation in the drill hole is 678 ft., but since the rocks dip about 14° toward the southeast here the correction for dip would make the true thickness approximately 658 ft. Possibly some of the lower sandstone should be included in the Chickamauga limestone.

The following surface section of these rocks measured through the gap by E. C. Eckel in 1905[1] gives a total thickness of 829 feet below the Chattanooga shale. It is stated that readings taken at a number of points in the gap gave very uniform dips, varying from 13½° to 15° southeast. It is not so stated but it is assumed that the surface measurements were corrected for the dip. As there is a covered interval of 246 feet below the lowest observed shale the debris probably overlaps the Chickamauga limestone and does not reveal the actual base of the Red Mountain formation. If 200 feet be deducted from the lowest interval the remainder will check fairly well with the above drill hole section and indicate an estimated thickness of 629 feet for the Red Mountain formation in the following section.

[1]Eckel, E. C., Op. cit., p. 175.

Section through gap of Red Mountain southwest of Fort Payne

		Ft.	In.
	Fort Payne chert		
	Chattanooga shale	24	6
Red Mountain formation	Sandstone and shale	306	
Red Mountain formation	Ore	2 to 2	6
Red Mountain formation	Shale parting	1 to 2	6 to 6
Red Mountain formation	Ore	2 to 3	6 to 0
Red Mountain formation	Shale	270	
	Covered interval, probably mostly limestone	246	
	Chickamauga limestone		
	Estimated thickness Red Mountain formation	629	0

On the south side of the Fort Payne gap are the remains of an old railroad grade where a track once passed along the south side of the creek connecting some old mine workings with a blast furnace in the south part of Fort Payne. The abutment of the grade is built of hard limy fossiliferous rock containing streaks of ferruginous material and probably representing the "gray" ore bed. There is an old entry, now caved in, on the south side of the gap, driven on the strike of the beds a few feet above creek level. It is reported that this ore bed was about 3 ft. thick where mined, but it is evident that only where the bed had altered to soft ore could it have possessed any value.

North of the Fort Payne gap, west of the city on the northwest slope of Red Mountain well below the crest of the ridge, are extensive strip trenches on the red ore bed. When visited in 1928 these trenches were filled with debris except in a few places where the upper part of the bed shows two seams of shaly ore 4 in. to 6 in. thick separated by 8 in. to 1 ft. of shale. At one place 1 ft. 8 in. of shaly, argillaceous material is exposed, probably one-half of which is shale. In one place near the gap a streak of very hard, calcareous, fossiliferous material containing a small per-

centage of iron occurs in the upper part of the seam. The beds dip about 18° S. 48° E. Evidently the calcareous bed where weathered yielded soft ore—hence the old workings here.

A drill hole near the east entrance to the gap southwest of Fort Payne, (Pl. 6, 4) which starts in beds of Fort Payne chert about 40 feet above the Chattanooga shale, is reported to have reached ore at a depth of 280 feet and to have passed through in turn 5 feet 3 inches of ore in an upper bench, 15 feet of shale, and 3 feet of ore in a lower bench. The dip of the beds is 12° S. 50° E. and, assuming that the above record is accurate, and correcting for the dip of the rocks, the following section should represent the ore encountered in the drill hole, but there is no information available as to the character of the "ore" itself. According to the reported thickness of Fort Payne chert passed through, this is apparently not the drill hole reported upon by McCalley.

Reported section of iron ore beds in drill hole at gap southwest of Fort Payne

	Ft.	In.
Shale		
Ore	5	1.6
Shale	14	8
Ore	2	11
Shale		

About 1 mile northeast of this gap, or directly northwest of Fort Payne, the following section was measured in an old trench where soft ore had formerly been mined by stripping and shipped to furnaces at South Pittsburg, Chattanooga, Dayton, and Bristol, Tenn. (Pl. 6, 5)

Section of iron ore bed one-half mile northwest of Fort Payne

	Ft.	In.
Shale		
Ore, shaly		9
Ore, soft		2½-4
Shale		5
Ore		5
Shale	1	3
Limonite—hard scale		1½-1¾
Ore, hard	1	8½
Shale		

Dip 15° S. 55° E. Total ore (including shaly ore), 3 ft. 4 in.

McCalley gives the following sections respectively west and northwest of Fort Payne which show that the ore was as scarce in the early days as at present:

Section of iron ore-bearing beds in center of sec. 7, T. 7 S., R. 9 E.
(M. II, pp. 152-153)

	Ft.	In.
Shale with a few streaks of ore		
Shale		4
Ore		2
Shale		½
Ore		2
Shale		4
Ore		1-2
Shale		4
Ore		2
Shale	1	
Ore, hard and limy	2	4

Total ore, about 3 ft.

Section of iron ore bed northwest of Fort Payne
(M. II, p. 152)

	Ft.	In.
Shale		
Ore		3
Shale		¾
Ore		2
Shale		½
Ore		8
Shale, debris	4	
Sandstone		4
Shale		

Dip about 30° SE. Total ore, 1 ft. 1 in.

The following analyses show the character of the hard ore and the soft ore that has resulted from weathering on the outcrop of the beds:

Analyses of red iron ore from vicinity of Fort Payne

Locality and type—a	Authority—b	Fe	SiO_2	Al_2O_3	CaO	Mn	P
Old mines ....S	M	56.02	7.93		n.d.		0.23
Old mines ....S	O	55.34	10.37		1.07		0.46
(Big sandy bed 1½ miles southwest of Ft. Payne)......S	O	46.97	13.82	6.19	1.14		0.4[illegible]
S	O	40.99	19.31	8.87	1.02		0.42
S	O	54.40	15.62	5.10	1.03		0.42
Old mines ....H	M	26.41	3.97		29.80		0.38
Old mines ....H	O	25.39	4.11		30.13		0.34
Outcrop ....H	M	29.93	3.35		28.44		0.49
H	O	28.20	4.19	3.86	27.51		0.41
H	O	33.22	10.40	7.77	18.59		0.44
Bottom 2 ft. (Big sandy bed 1½ miles southwest of Ft. Payne)......H	S	10.04	11.11	4.22	36.25		
Top 4½ ft., ferruginous sandstone	S	7.12	73.08	10.16	0.74		

a—S, soft ore; H, hard ore.
b—Authority: M. McCalley, Op. cit., pp. 153-154; O, Owners of property, shown in prospectus; S, Standard Steel Co.

Certain of these analyses were made for the former Fort Payne Fuel and Iron Co. which was endeavoring to interest investors in the property about 1909 and are taken from the prospectus issued for this purpose. The analyses show a lean hard ore, too lean in fact to be mined for furnace supply under present conditions of blast furnace practice, but, of course, the soft ores derived from the hard ores high in lime carry generally fairly good percentages of iron that are impressive to persons not familiar with the iron industry in the South. The soft ore has, however, been exhausted from this vicinity so far as recovery on a large scale is concerned.

Between 1887 and 1893 the Fort Payne district experienced a "boom" based on alleged reported vast deposits of iron ore and coal. Elaborate preparations were made for the establishment of an iron and steel industry, apparently without adequate consideration as to whether engineering and geological data showed that sufficient supplies of the necessary raw materials were available locally. This period long antedates the experience of the senior writer in the Alabama iron ore fields, but there are reports that one blast furnace was built and construction of another one as well as of a rolling mill was begun. A large hotel and several

business blocks were built. This first boom evidently collapsed about the time of the panic of 1893, without, however, having contributed anything creditable to the industrial history of Alabama. In the valuable and interesting history by Ethel Armes,[1] the following reference is made to this situation: "In DeKalb County, along the line of the A. G. S., a marked degree of prosperity was shown late in the eighteen-eighties. "Boom towns" sprang up all over the county, chief among them being Fort Payne, the county seat. Here two blast furnaces and a steel plant were eventually constructed, but never operated . . . . later . . . . the plants were dismantled and sold for scrap iron."

This "boom" and the Fort Payne furnaces are described by Woodward.[1]

The highway from Fort Payne toward Chattanooga passes from Little Wills Valley to the valley of Big Wills Creek through the next gap in Red Mountain, about 2 miles north-northeast of Fort Payne. (Pl. 6, 6). No true iron ore crops out in this gap although the rocks are generally well exposed, but the "big sandy" ferruginous bed appears near the base of Red Mountain. A traverse along the west slope of the ridge for more than a mile northeast of the gap revealed no ore in place nor any prospects that showed ore. A few small pieces of soft ore, none more than 2½ inches thick, were noted as float on the west foothills of the ridge. It is reported, however, that soft ore occurs in this vicinity, and McCalley (II, p. 151) mentions a seam of ore 6 inches thick as outcropping in the branch in the SE¼ NE¼ sec. 32, T. 6 S., R. 9 E. There are evidences of unconformity between the Chickamauga limestone and the Red Mountain formation in this vicinity, and there seems a possibility that what has been called the "big sandy" ferruginous bed in this vicinity may be in the upper part of the Chickamauga instead of in the Red Mountain formation.

In the gap of Red Mountain (Pl. 6, 7) just south of the Fort Payne-Stevenson quadrangle boundary and about 4½ miles northeast of Fort Payne the Red Mountain formation is well displayed

[1]The Story of Coal and Iron in Alabama, pp. 320-321: The University Press, Cambridge, U. S. A., 1910.

[1]Woodward, Joseph H., II., Alabama Blast Furnaces: Woodward Iron Company, Woodward, Ala., pp. 70-71, 1940.

with an outcrop width of about 0.4 mile, but no iron ore crops out in the gap and a life-long resident at the west end of the gap stated that he knew of no ore being found here. Nevertheless, McCalley (M. II, p. 151) mentions an outcropping of very good ore about 1 ft. 3 in. thick, near the center of sec. 22, T. 6 S., R. 9 E., which would be in this vicinity. Later on in this survey, two ferruginous beds separated by a thin shale parting were noted on the northeast side of the road through this gap. The beds are exposed on a low foothill in the valley on the northwest side of the ridge. Each bed is 9 inches thick and is composed of friable sandy clay through which is distributed blebs and small irregular masses of fossiliferous hematite. The material is low in specific gravity, breaks out in angular blocks from 6 to 9 inches thick, and has a dull red color. The beds dip about 15° southeast. The material is not, by any means, an ore of iron.

A 3-inch bed of hard, limy ore, dipping 15° S. 65° E. was noted in an old road on the northwest side of Red Mountain just northeast of a creek that cuts through the ridge about 1 mile north of the station of Allen on the Alabama Great Southern Railroad. McCalley (M. II, p. 151) noted an outcrop of bright red ore 1 ft. 2 in. thick in the northern part of the SW¼ of the NE¼ of sec. 22, T. 8 S., R. 9 E., and 6 in. to 8 in. of good hard ore on the ridge in the NW¼ NW¼ sec. 14, T. 6 S., R. 9 E., dipping about 30° to the southeast. This same seam appears also in sec. 11 (M. II, p. 150). As these seams are apparently not of commercial value no attempt was made to find them as they would have required prospecting in order to ascertain their thickness. These latter localities are about opposite the station of Allen.

Allen (formerly Cordell).—In the gap through which a creek flows westward to Big Wills Creek about 1 mile southwest of Allen, the Red Mountain formation lies on the northwest slope of the ridge (Pl. 7, 1). The only material resembling ore seen here was a bed of hard ferruginous limestone 3 inches thick, dipping 12° to 15° S. E. On the northwest side of the ridge in the NW¼ sec. 14, T. 6 S., R. 9 E. a thin seam of fossiliferous red ore from 6 to 8 inches thick and two thinner seams were observed in a shallow prospect pit. The ore had distintegrated and was mixed with clay. The total thickness of ore, clay and interbedded shale apparently was less than 2 feet but exact thicknesses could not be determined. No ore was seen in the formation between this gap and Valley Head. (See Fig. 10).

Fig. 10. View northwestward from brow of Lookout Mountain near Mentone. The village in the foreground is Valley Head, at the head of Little Wills Valley, which is separated from Big Wills Valley by the wooded ridge, Red Mountain. West Red Mountain lies on the far side of Big Wills Valley. The highland on the horizon is Sand Mountain in the vicinity of Pea Ridge.

Valley Head.—A section showing several seams of ore in a ravine about 3¼ miles southwest of Valley Head is as follows:

Section of iron ore in SE¼ NE¼ sec. 1, T. 6 S., R. 9 E. (M. II, p. 149)

	Ft.	In.
Debris		
Ore, good hard ledge, bottom 1 to 2 in., limonite	4	7-8
Debris, most likely covers shale, about	4	6
Ore, good hard ledge		6
Debris, most likely covers shale, about	4	
Ore, good hard ledge, upper part fossiliferous	1	0-2
Sandstone		

Dip 30° to 35° SE. Total ore, about 2 ft. 2 in.

In the ridge northwest of Valley Head soft ore has been mined to a very small extent from open cuts north and south of the gap through which the local road to Hammondville passes. (Pl. 7, 2). These old cuts have been obscured by debris for many years but in a quarry of shaly sandstone on the north side of the gap the following section was measured:

Section of iron ore beds at north side of gap northwest of Valley Head.

	Ft.	In.
Shaly sandstone		
Ore, very soft		6
Shaly sandstone	3	
Ore, soft, decomposed, with parting of shale 1 to 2 in. thick, below middle of seam		8
Shaly sandstone	15	
Ore, lean, limy, hard, fossiliferous		5½
Shaly sandstone, breaking out in slabs and post-like pieces		•

Dip 22° S. 62° E. Total soft ore in 2 seams, about 1 ft.

Northeast of the Valley Head openings McCalley noted the following section at some old diggings:

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Section of iron ore beds about 2¾ miles north-northeast of Valley Head

	Ft.	In.
Shale		
Ore, slightly argillaceous		2½
Shale, partly replaced by limonite		2
Ore, soft		8½
Shale, in part replaced by limonite	9	
Ore mixed with clay		5-6
Shale, partly replaced by limonite		3
Ore, soft		8
Shale	1	1
Ore, soft		4
Shale		
Debris		

Dip about 43° S. 60° E. Total ore, good and poor, in about 12 feet of strata, 2 feet, 4 inches

Farther northeast the ore bed shows greater thickness in places, McCalley having noted a total of more than 4 feet in what he regards as the top seam at some old diggings about 4 3/4 miles north-northeast of Valley Head. (Pl. 7, 5)

Section of iron ore near center of NE¼ sec. 4, T. 5 S., R. 10 E.
(M. II, p. 147)

	Ft.	In.
Shale, debris		
Ore, loose	1	8
Shale		4
Ore		2
Shale		4-5
Ore		3-4
Shale, a few streaks of ore		4
Shale, may have streaks of ore in places	2	8
Ore, irregular thickness, with streaks of shale in places	0-1	6
Shale, about	4	
Ore, visible to depth of	1 to 1	3 to 6

Dip 45° SE. Total ore, about 4 feet

Battelle (formerly Eureka)—In the vicinity of Battelle the red ore was formerly mined during a few years in a number of places on the outcrop and also underground. Mining in this

vicinity was rendered possible because of the presence of more than one bed of workable ore and because of local thickening of some of the ore beds. Within the Red Mountain formation four beds of more or less ferruginous material are distributed approximately as follows, according to Eckel[1] who visited the locality in 1905 when the mines were in operation:

Section of iron ore-bearing part of Red Mountain formation near Battelle

	Approximate thickness Feet	Dip Southeast
Ore bed, 1, (top)	4½	23° to 45°
Shale	40	
Ore bed, 2, (sandy, of no value)	2	23° to 45°
Shale	300	
Ore bed, 3, (of very limited extent)	3	85°
Shale	200	
Ore bed, 4,	3½	85°

According to observations of McCalley the Red Mountain formation here contains 7 or 8 ferruginous streaks or seams. Four of these seams that cropped out in the road crossing the ridge of Red Mountain strata near the former clay mines southwest of Battelle are distributed as follows:

Section of ferruginous part of Red Mountain formation in NE¼ NE¼ sec. 34, T. 4 S., R. 10 E.
(M. II, p. 145)

	Ft.	In.
Ore, elsewhere noted as shaly, thickness about	2	6
Strata	12-15	
Ore	2	4
Strata, about	210	
Ore, about	3	
Strata	50-55	
Ore	1	6

Dips variable. Upper beds dip very steeply but lower beds dip at moderate angles.

[1]Eckel, E. C., Op. cit., p. 174.

McCalley, (M. II, p. 142) who witnessed some of the active open-cut mining, states that the best, or top (?), ore seam and the one next to it were mined on the outcrop from near the center of the NW¼ of sec. 26, T. 4 S., R. 10 E., southwestward for some 3 miles. He states that the ore beds have pockets of unusually thick ore, known locally as "ore wallows," and that subsequent mining demonstrated that such pockets could in a short time be exhausted. In 1905 a quantity of the soft, surface ore had been removed and mining was under way in three slopes, all of them reported to be about 200 feet long; bed 4 was mined from two small and nearly vertical openings. The ore then obtained was mostly hard, high in lime and low in iron, as is indicated in the analyses on page 158, which show for the hard ore a range in lime, CaO, of 17.5 to 26 per cent and in iron of 23 to 32.5 per cent. The ore was mined by the Ragon Mining Co. to supply the blast furnace of the Lookout Mountain Iron Co. at Battelle. The ore was mined from trenches and slopes on the ore bed on the west side of the ridge at Battelle and since there is no convenient gap in the ridge at this place an 800-foot tunnel was driven through the ridge a short distance southwest of the furnace and the ore was carried by tramway through the tunnel to the furnace in the valley alongside the Alabama Great Southern Railroad. In the slopes the soft ore generally extended downward 20 ft. to 30 ft., but the line of demarcation between the soft and hard ore was somewhat irregular depending upon the topography. This furnace was in blast from autumn 1904 to March 1906, and so far as can be ascertained was not again operated up to the time of its removal in 1917 to Sakchi, India, where it was rebuilt and operated by the Tata Iron and Steel Co.

From records obtained in 1911 the three slopes driven on the most important ore bed were in January, 1906, respectively 385 feet, 231 feet, and 344 feet long. At the bottom of slope No. 1 the ore bed was reported 4 ft. 7 in. thick; in No. 2 slope it was 4 ft. 5 in. thick, but at the end of No. 3 slope the ore had pinched out entirely. The thicknesses indicated above probably include a shale parting of variable thickness. A 4-foot section about 10 ft. below the mouth of one of the slopes, (Pl. 7, 6) which was as far as one could enter on account of water measured as follows:

Section of iron ore bed 10 feet below mouth of No. 2 airway at Battelle

	Ft.	In.
Shale		
Ore, hard, calcareous, granular, fossiliferous	2	8
Shale		1
Ore, similar to upper bench	1	3½

Dip 30° S. 50° E. Total ore, 3 ft. 11½ in.

Some of the ore on a dump, exposed to weather, shows argillaeous material in nodules and lumps. The fossils noted included streptelasma, brachiopods, trilobite remains, and crinoid buttons. The fossiliferous streaks are characteristically limy. This section probably would not be duplicated 5 yards distant in any direction, the ore bed is so variable. The shale parting is reported to reach a thickness of several feet and the thickness of the ore to decrease to about 3 feet in places. The dip varies from 22° to 42° in the workings. A hole drilled 1848 feet southeast of the outcrop of the main ore bed is reported to have reached the ore at a depth of about 900 feet, which shows a general dip of about 25°. According to other drill records there are in this vicinity five seams of ore in the formation ranging from 1 ft. to 2 ft. 8 in. in thickness, besides five seams having a thickness of 6 to 8 in. It may be that within the formation there is sharp folding and possibly faulting which repeat the outcrop of some of the beds and change their direction of dip.

A section given by McCalley of an outcrop on a spur that extends northwest from the ridge about one-half mile northwest of Battelle is as follows:

Section of iron ore bed in SE¼ SE¼ sec. 27, T. 4 S., R. 10 E.
(M. II, p. 144)

	Ft.	In.
Shale, may carry some ore		
Ore	1	3
Shale, only in places		1
Ore		5
Ore, clay, mining		1-2
Ore	1	1
Ore, clay, mining		1-2
Shale		

Dip 60° NW. (overturned) Total ore, about 3 ft.

The west entrance of the old haulage tunnel mentioned by McCalley lies in the SW¼ NE¼ sec. 34, T. 4 S., R. 10 E. This area was visited by the authors in 1941 and the following section of an ore bed was measured on the southeast bank of the West Fork of Lookout Creek where a farm road crosses it about 600 feet northwest of the tunnel entrance:

Section of iron ore bed in the NW¼ SW¼ NE¼ sec. 34, T. 4 S., R. 10 E.

	Ft.	In.
Shale with sandstone layers		
Ore, thins to southwest and northeast		5 to 5½
Shale		4
Ore, with shale partings	1	3
Shale		

Dip about 65° S. 48° E. Total ore about 1 foot, 8 inches

The outcrop of this bed, which is the most northwesterly of those exposed in this area, can be traced almost continuously on the strike to the northeast for more than 1½ miles by a trench and in places by depressions which have been formed by the collapse of roofs of drifts on the ore bed. About 0.8 mile northeast of the tunnel entrance the following section was measured on this bed (Pl. 8, 1):

Section of iron ore bed .8 mile northwest of west entrance of Battelle tunnel

	Ft.	In.
Shale		
Ore, soft		2
Shale		1
Clay, mixed with ore		3½
Ore, soft, fossiliferous, appears argillaceous		7
Shale		6
Ore, hard		3
Clay, mixed with a little ore		4
Shale		

Dip 70° S. 50° E. Total ore, about 1 foot, 3 inches.

A discontinuous series of trenches lying about 150 feet to the southeast parallels the above mentioned trench over most of the distance traversed. The openings were caved and no ore bed could be seen or measured. Rocks exposed in two of the openings had steep dips toward the southeast.

About 300 feet northwest of the tunnel entrance an ore bed was exposed where it had been worked for soft ore by a mechanical shovel in a trench in 1941. A section measured on this bed follows:

Section of iron ore bed 300 feet north of west entrance of Battelle Tunnel

	Ft.	In.
Shale		
Ore, fossiliferous, oolitic, friable	1	4
Shale		

Dip 25° S. 60° E. Total ore 1 foot, 4 inches.

The outcrop of the ore bed on which most of the mine slopes in this area were driven lies approximately 150 feet west of the tunnel entrance. Trenches which extend southwestward for nearly ¼ mile were made on this bed for soft ore in 1941. The ore bed ranges in thickness from 1 foot, 4 inches to 2 feet, 4 inches, and the dip of the bed varies 55 to 63° S. 45° to 60° E. A representative section made about 500 feet southwest of the tunnel entrance follows:

Section of iron ore bed about 500 feet southwest of west entrance of Battelle tunnel

	Ft.	In.
Shale		
Ore	1	
Shale, partly replaced by limonite		2
Ore		3
Clay, mixed with ore		1½
Shale		2 to 3
Ore		6
Shale	1	11
Clay, mixed with ore		4 to 6

Dip 55° S. 45° E. Total ore about 1 foot, 9 inches

The relative positions and dip of the ore beds and the continuity of the trenches on the outcrops indicate several ore beds in normal sequence dipping southeast. It is possible, however, that close folding and faulting have duplicated the outcrops of the beds, but if so, the evidence of such deformation is not readily apparent.

Many analyses of the hard ore and a few of the soft ore at Battelle are available. From these analyses, which are given in the following table, it is readily apparent that the local blast furnace could not survive in competition with larger furnaces in other parts of Alabama supplied with richer and more abundant deposits of ore.

Sample and type—a
Slope No. 1 ....
From cars, 11 days ......
Upper bed, Slope 1, ...
Upper bed, Slope 1, ...
Upper bed, Slope 2, ...
Upper bed, Slope 3, ...
Upper bed, Slope 3, ...
Bottom bed, Slope 4, ...
Bottom bed, Slope 5, ...
Average all slopes ....
Average all slopes ....
Good ore ....
Stockpile, semihard ....
Same sample, ... {
natural and dried ...... }
½ mi. SW. Battelle .....
½ mi. NW. Battelle .....
1 mi. N. Battelle ....

a—H, hard ore; S,
b—D, dry basis; N
c—L, Lookout Mou

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Sections of ferruginous beds in NW¼ NW¼ sec. 26, T. 4 S., R. 10 E.
(M. II, p. 143)

	Ft.	In.
Debris, shale; debris most likely covers shale		
Loam, very red, probably covers soft ore		4
Shale	4	3
Ore, soft or badly weathered, clayey		1-2
Ore, good		4
Clay streak		⅛
Ore		2
Shale		¼
Ore		11
Shale		2
Ore		3-4
Shale		¼
Ore, soft and clayey		1
Ore		6
Shale		

Outcrop folded so that dips are from 70° NW. to 60° SE.
Total ore, about 4 ft.

(M. II, p. 142)

	Ft.	In.
Shale, visible	3-4	
Ore	1	7
Shale		2
Ore		6
Shale, dark		1
Ore		5
Loam, very red, with a little ore, visible		8

Total ore, about 2 ft. 6 in.

About one-half mile southwest of the Alabama-Georgia line
l. 8, 2) the width of outcrop of the Red Mountain formation is
out one-quarter mile and according to McCalley it contains seven
eight seams of ore, some of which are mere streaks. The lower
e of these seams are shown in about 100 feet of the formation
cording to the following section:

Section of ferruginous beds near center of NE¼ sec. 23, T. 4 S., R. 10 E.
(M. II, p. 141)

	Ft.	In.
Ore, with 3 in. parting of shale near center	1	3
Shale, debris most likely covering shale	18	
Ore	1 to 1	2
Shale, debris likely covering shale	15	
Ore	1	
Shale, debris likely covering shale	30-35	
Sandstone, fine grained, persistent		10
Shale, debris likely covering shale	12-15	
Ore		6-8
Shale, debris likely covering shale	20-25	
Ore, reported		

Dip of two lower seams, 65° - 70° SE.

These are the last descriptive details that will be given for the strip of the Red Mountain formation on the southeast side of Wills Valley. The portion northeast of Valley Head is, of course, not strictly within Wills Valley but in the drainage of Lookout Creek which flows northeast toward the Tennessee River. The anticlinal structure has controlled the development of drainage along the main northeast-southwest anticlinal axis.

The strip of Red Mountain formation on the northwest side of the Wills Valley anticline, beginning at the southwest, near Littleton, will be described in the text on the northwest side of Wills Valley, pp. 161-206.

Resume of iron ore reserves in Wills Valley, southeast side

The approximate length of outcrop of iron ore beds 2 feet or more thick on the southeast side of Wills Valley between Attalla and the Alabama-Georgia State line is 27.6 miles, or 145,728 feet. The average thickness of the bed appears to be about 3 feet. The average width of workable ore down the dip is placed at 1,000 feet, which is far from reaching the escarpment of Lookout Mountain, but should include some hard ore. The estimated total quantity of recoverable soft, semihard, and hard ore appears to be approximately 30,970,000 long tons, which is the largest tonnage indicated for any of the eight subdivisions of northeast Alabama which possess an appreciable extent of ore 2 feet or more in thickness.

WILLS VALLEY, NORTHWEST SIDE

(Plates 3, 5, 6, 7, 8)

The strip of Red Mountain formation on the northwest side of the Wills Valley anticline is not exposed continuously as is the southeastern strip of the formation in Red Mountain. From near Littleton, Etowah County, about 4 miles due northwest of Attalla, the outcrop extends northeast about 2 miles, beyond which it is cut out by faulting for a distance of about 6 miles or to near Haworth, where there is a strip less than 1 mile long. Beyond this the formation is cut out by a fault for about 2 miles and then extends northeast for a distance of about one mile. From here northeast 1.1 miles or to about the DeKalb County line the formation is again cut out by a fault. From this county line northeastward there is a strip about 5 miles long terminating in a fault which extends for about a mile, beyond which the formation appears again and may be traced except for minor breaks continuously to the Georgia line, beyond Sulphur Springs. Nearly everywhere the beds dip steeply so that the distance across the outcrop is narrow. Only a little mining has been done anywhere on this strip of the formation and that together with what little prospecting work has been done was evidently not very encouraging and consequently not so much data could be obtained as in other areas where the ferruginous beds have been opened at more places. Notwithstanding the scarcity of data the fact seems well demonstrated that the ore bed, which theoretically passes under Sand Mountain along the northwest side of Wills Valley, is of decidedly poorer quality than the corresponding bed on the Lookout Mountain side of the valley, and sustains the belief in the minds of the geologists engaged in this study that the ore beds of the Red Mountain formation deteriorate toward the northwest and probably do not extend far northwest of the escarpment of Sand Mountain.

Littleton.—Northeast of Littleton, a station on the Nashville, Chattanooga & St. Louis Railroad, 4 miles northwest of Attalla, there is a strip of Red Mountain formation about 2 miles in length

limited in nearly all directions by faults, acording to the geologic map in the Gadsden geologic folio. Practically the only mining on the northwest side of Wills Valley has been in this area of the formation and near Sulphur Springs, about 55 miles to the northeast. In October, 1928, this locality was visited in company with R. A. Drake, of Attalla, who formerly had charge of some mining operations here. About half a mile northeast of Littleton (Pl. 3, 7) a slope, last operated about 1917, goes down about 80 feet on beds that have been overturned. At the top of the slope the dip is 28° to 35° S. 33° E., but is steeper toward the bottom. Near the top of the slope the ore shows as follows:

Section of iron ore bed in slope half a mile northeast of Littleton

	Ft.	In.
Shale		
Ore, soft hematite		8
Clay, local lense		0-2
Ore, limonite scale		1
Ore, soft hematite	1	7
Shale		

Total ore, 2 feet 4 inches.

About 12 feet down this slope a small fault drops the ore down about 4 feet on the southeast. The fault plane is nearly vertical but in places hades 5° to 7° toward the southeast, and is therefore a normal fault. It is reported that two more faults of about 4-feet throw occur below within the slope. The beds become steeper but not vertical nor do they show a normal northwest dip anywhere. Water prevented examination of the slope below a depth of about 30 feet but it was reported that hard hematite was reached at the bottom of the slope.

It was reported that about two carloads of ore a day were shipped from here during mining operations which continued at intervals for three years, the ore going to the furnaces of the Gulf States Steel Co. at Alabama City and to the La Follette Iron Co. at La Follette, Tenn. When picked free of shale the soft ore carried as high as 52 per cent of iron, it is reported.

Workings a quarter of a mile northeast of the first slope consisted of strip trenches and drifts along the strike of the ore and

a slope in which the ore bed dips about 40° SE. It is here reported to be about 2 feet 8 inches thick. Some of the hematite has been altered to a bright-red hydrous oxide of iron. Two carloads of ore carrying about 40 per cent of iron are reported to have been shipped to the Gulf States Steel Company.

The main workings of the Littleton mining area belonged to the McDuffie Mining Co., and were located in a hollow about 1 mile in an air line northeast of Littleton. (Pl. 3, 8) A drift extending southwest on the strike of the beds shows 2 feet 8 inches of ore dipping 45° S. 30° E., but the dip becomes steeper below. One fault is reported to break the ore apart for a distance of 15 feet where the bed is bent to a more nearly vertical position. A large slope in the hollow between two knobs goes down at a dip of 52°, S. 35° E., but steepens to about 75° at the bottom. The length of this slope is reported to be about 90 feet. The ore at the bottom was covered by caving, but the shale roof was standing well farther up the slope. About a quarter of a mile northeast of this slope the ore bed is shown in a gully which exposes a good section of part of the Red Mountain formation. The ore bed was 2 feet 8 inches thick, including a 6-inch bed of limonite that had replaced shale. The section follows:

Section of iron ore bed in gully 1¼ miles northeast of Littleton

	Ft.	In.
Shale		
Ore, hematite with nodules of shale in upper part, replaced by limonite; some of the hematite is soft, some is hard and limy	1	3
Ore, limonite that has replaced shale		6
Ore, hematite, partly hard, partly soft		11
Sandstone, ferruginous		
Dip 57° S. 40° E.		
Total ore, 2 feet 8 inches.		

This ore appears to be of good quality. It is rather fossiliferous, showing many small brachiopods.

The place farthest northeast in this outcrop strip of the Red Mountain formation where iron ore has been dug is about a quarter of a mile northeast of Noble's store. About two carloads of ore were obtained in the SW¼ SW¼ sec. 10, T. 11 S., R. 5 E.,

from some pits. A reported thickness of 1 foot 6 inches was not seen but blocks of ore 10 inches thick were noted. This locality (Pl. 3, 9) is about 2½ miles northeast of Littleton.

This area was visited many years ago by J. R. Ryan before much development work was done. He reported measuring a seam 7 inches thick in a cut three-quarters of a mile northeast of Littleton, 200 yards east of the foot of Sand Mountain, also the following sections which seem to coincide with the ore in corresponding localities noted by the authors:

Section of iron ore bed in small tunnel 1¼ miles northeast of Littleton, close to foot of Sand Mountain

	Ft.	In.
Shale		
Ore, soft, dirty		2
Ore, good		1
Ore, dirty		2
Ore, good		8
Shale		1
Ore, good		8
Ore, dirty		9
Shale		

Dip 35° SE. Total ore—2 feet, 6 inches.

Section of iron ore bed 2¼ miles northeast of Littleton, 350 feet west of Coxville road (Pl. 3, 9)

	Ft.	In.
Shale		
Ore, soft	1	6
Ore, brown		6
Shale		

Dip 15° to 20° SE. Total ore, 2 feet.

Information furnished by Mr. C. A. Moffet, of Birmingham, President of the Gulf States Steel Co., is to the effect that in three pits about half a mile from the railroad at Littleton about 2 feet 6 inches of clean, soft ore was shown, the dip of which varied from 35° to 60° southeast, indicating a considerable overturn of the ore-bearing beds. McCalley (II, p. 208) reports about 2 feet of ore parted in the middle by 2 feet of shale at a depth of 10 feet in a shaft about 100 yards from the foot of Sand, or Raccoon Mountain:

Section of iron ore bed in SW¼ sec. 17, (16), T. 11 S., R. 5 E.

	Ft.	In.
Shale, yellowish		
Ore, soft, good, about	1	
Shale, yellow, about	2	
Ore, seemingly about	1	
Dip 70° SE.		

McCalley states that the upper bench of ore is about 3 feet thick on the outcrop and in a vertical position, which indicates much variation in thickness and dip within a few feet, probably due to squeezing and local thickening during earth movements. The seam can not be followed continuously, but on the top of a ridge in the SW¼ sec. 16, T. 11 S., R. 5 E., an ore seam outcrops having an upper bench 1 foot 3 inches thick separated by a few inches of shale from a lower bench 1 foot 6 inches thick. This seam has been badly disturbed and dips about 20° SE. Other showings in a shaft are noted as 1 foot 6 inches to 2 feet thick.

When this area was visited in 1939 two prospects had been opened, one southwest and one northeast of the old slopes mentioned above. These openings lie about in the center of the sec. 16, T. 11 S., R. 5 E., and are presumably on the same seam measured by McCalley. The ore exposures available for measuring ranged from 10 inches to 1 foot, 10 inches in thickness, with an average of about 1 foot, 4 inches. In places there are shale partings which slightly reduce the total thickness of the ore bed. Mining activity soon ceased, and no further work had been done when the area was last inspected in 1941.

These sections generally do not give promise of ore of value unless sufficient soft ore might be found on the outcrop to repay the short wagon haul to the railroad, and it is probable that most of this has now been removed.

Coxville.—Near the site of the former Postoffice of Coxville no Red Mountain formation could be found and none shows in Fisher Creek, which emerges from Cox Gap in Sand Mountain, but float fragments of Chattanooga shale and of Red Mountain hard ore were found in a field just northeast of the creek. Following the Sand Valley road toward the northeast in the area designated

as Bangor limestone on the Gadsden Geologic Folio map small areas of both Red Mountain formation and Fort Payne chert not indicated on the map are found badly dislocated and twisted around by the fault which brings the Cambrian or Ordovician cherty dolomite up against these formations.

Haworth.—The next definitely mapped small area of Red Mountain formation toward the northeast is 3½ miles northwest of Crudup station at what is called Haworth on the Gadsden topographic map. This outcrop as mapped is less than a mile in length. Where the wagon road crosses the gully that comes down from "Leed" (or Leith) Gap, shale of the Red Mountain formation was seen under the bridge with black Chattanooga shale and white Fort Payne chert in regular succession toward the northwest, all overturned and dipping steeply southeast. No iron ore is exposed in this gully but it appeared where it had been dug about 0.2 mile toward the northeast. (Pl. 3, 10) It is reported that the bed was about 1 foot 6 inches thick, but this could not be measured and a float block only 5 inches thick was seen. It is possible that the outcrop of Red Mountain ore may have been repeated by faulting in this area, for it is reported that just north of the wagon road that goes up Sand Mountain a prospect was driven about 60 feet in length that cut a 4-foot bed of good ore. McCalley records the existence of a seam, in what may be this same shaft, that was 1 foot thick on one side of the opening and 1 foot 6 inches thick on the other side. In this area the Red Mountain strata crop out for nearly half a mile and in one place show the following section:

Section of iron ore bed in NE¼ sec. 30, T. 10 S., R. 6 E.
(M. II, p. 211)

	Ft.	In.
Shale, ore in a thin streak		
Ore	2	6
Shale	1	2
Ore		4
Shale		

Dip 65° E. SE. Total ore, 2 feet 10 inches.

Duck Spring.—Northeast of the above locality, beyond a gap where the ore-bearing strata appear to have been faulted out the following section was noted in a pit in an old field on top of a low ridge:

Section of iron ore-bearing beds in SE¼ SW¼ sec. 17, T. 10 S., R. 6 E.
(M. II, p. 211)

	Ft.	In.
Ore, good, not quite	2	
Shale, about	8	
Ore	1	6
Shale		

Total ore nearly 3 feet 6 inches.

Other sections northeast of the former Duck Spring Postoffice made by McCalley are given below:

Section of iron ore bed in NE corner NW¼ sec. 9, T. 10 S., R. 6 E.
(M. II, p. 212)

	Ft.	In.
Shale		
Ore, soft, good solid ledge, about	1	3
Debris		

Dip about 40° E. SE.

Outcropping in road in NW¼ sec. 9, T. 10 S., R. 6 E.

	Ft.	In.
Debris		
Ore, soft, good, same solid ledge as in above section, about	1	3
Shale, about	15	
Ore, may have some shale partings in upper part	2	
Shale, sandstone	6-8	
Ore, shaly, sandstone in alternate streaks, about	4	
Debris		

Dip about 50° SE.

These sections are near the north border of Etowah County. It is understood that the DeKalb-Etowah County line is now about 1 mile north of where it is shown on the Gadsden topographic map, but that it is correct as shown on the Fort Payne topographic map. The relations of the ore seams in an old road west of the highway about 1 mile northeast of Duck Spring as noted in 1928 were as follows (Pl. 3, 11):

Section of iron ore-bearing beds about 1 mile northeast of Duck Spring

	Ft.	In.
Shale		
*Ore, soft, good quality, contains some limonite, good quality		4
Shale	8	0
Ore, soft, good quality, contains some limonite	1	2
Shale		

Dip about 45° nearly east. Total ore 1 foot, 6 inches.

This ore bed can be traced on its strike at least a quarter of a mile southwestward. Much debris of ore shows in the field back of a house and from a large prospect trench good sized blocks of ore 5 inches to 6 inches thick have been obtained.

Near, or possibly at the same locality, McCalley measured the following three sections which show 1 foot 6 inches to 2 feet 6 inches of ore, some of it shaly, parted by 1 to 3 feet of shale, and dipping very steeply:

Section in SW corner SE¼ sec. 4, T. 10 S., R. 6 E.
(M. II, p. 120)

	Ft.	In.
Shale		
Ore, shaly	1	6
Shale	2	
Ore	1	
Shale		

Total ore about 2 feet, 6 inches.

Sections in SW¼ SE¼ sec. 4, T. 10 S., R. 6 E.
(M. II, p. 121)

	Ft.	In.
Shale		
Ore, good		8
Shale	15	
Ore		10
Shale		

The upper ore dips about 60° SE. and the lower ore 70° to 75° in the same direction. Total ore about 1 foot, 6 inches.

(M. II, p. 122)

	Ft.	In.
Shale		
Ore, red, good, soft	1	3
Shale	8	
Ore, red, good, soft	1	3
Shale		

Dip 80° to 85° E. SE. Total ore 2 feet, 6 inches.

Continuing northeastward in Etowah and DeKalb Counties along the northwest strip of Red Mountain formation in Wills Valley no important thicknesses of good quality iron ore are found, although there are three or four different seams of ore in the section. Not many places in this strip were inspected by the present writers, for McCalley painstakingly had followed the outcrop practically its whole length, at a time when many prospects had been recently dug and the ore seams were visible.

In the area of outcrop of the Red Mountain formation along the southeast base of Sand Mountain in southern DeKalb County wherever the thickness of an ore bed is enough to make it possibly workable underground the quality appears to be poor. Several instances are given by McCalley[1] of ore outcrops in T. 9 S., R. 6 E., notably in sections 34, 26, 23, 24, 13, and 12, the better of these showing about 2 feet of ore. There is also a "big sandy" seam of ferruginous rock in this locality.

Roden Gap.—One-half mile southwest of the cross-roads near Roden Gap two seams of red ore separated by about 25 feet of shale were observed. The western, or upper seam ranges from 3 inches to about 1 foot 7 inches thick, and the lower seam shows a maximum thickness of about 1 foot 8 inches. This seam shows a much disturbed, squeezed, and faulted condition. It is exposed in a stream gully, has been subject to moisture, and is partly altered to limonite. (Pl. 5, 6.) The ore contains some shale streaks but is fairly rich in iron oxide and might be termed a good quality ore. Possibly these two outcrops are of the same bed that has been broken apart by faulting.

[1]McCalley, Henry, Op. cit., pp. 122-125.

In the vicinity of Cotnam little evidence of ore could be found except some small fragments of fossil ore in a field and there is evidence of faulting locally having displaced beds of the Red Mountain formation.

An elliptical-shaped knob of high grade limestone is exposed on the east side of a road about ½ mile northeast of Cotnam, DeKalb County. The rock is a hard, dense, crystalline variety, oolitic and fossiliferous in places. It is probably of Mississippian age. A similar deposit of limestone was noted in Sand Valley, 1½ miles southwest of Horton Gap (Plate 3). These occurrences are recorded here in the interest of the supply of fluxing stone for blast furnace use. The following analysis of a specimen of the limestone near Cotnam shows it to contain a comparatively low percentage of impurities.

Analysis of limestone from near Cotnam, Ala.[1]

	Percent
Ignition loss	43.05
Silica (SiO_2)	1.85
Iron Oxide (Fe_2O_3)	0.19
Alumina (Al_2O_3)	0.13
Lime (CaO)	54.60
Magnesia (MgO)	0.29

Dawson.—The following two sections were measured by McCalley south of Dawson, or Nicholson Gap:

Section in NW¼ SW¼ sec. 5 (6?), T. 9 S., R. 7 E.
(M. II, p. 126)

	Ft.	In.
Shale		
Ore, shale, in alternate streaks		9-10
Shale		3
Ore	1	
Shale, ore, in alternate streaks		1-2
Ore, shaly on top	3	2
Shale		
Dip about 60° SE.		

[1]Analysis No. 24697, Emerson P. Poste Laboratories, Chattanooga, Tenn.

Section in NW corner sec. 33, T. 8 S., R. 7 E.
(M. II, p. 126)

	Ft.	In.
Ore, about	4	8
Shale, about	18	
Ore, about		4
Shale	10-12	
Ore, about		3

Dip about 70° SE.

The unusual thickness of 4 feet 8 inches of ore having been recorded by McCalley in the last section without qualification an endeavor was made to check it. There was found about half a mile south of the road leading to Dawson (Pl. 5, 7.) in a prospect pit reported as dug by H. F. Bardeleben about 1881 an irregular bed ranging from 2 feet 9 inches to 4 feet 3 inches in thickness of shaly ore, and this bed, it was reported, had been examined by McCalley.

Section of ore bed in NW¼ sec. 33, T. 8 S., R. 7 E.

	Ft.	In.
Shale		
Ore		0-8
Ore, shaly		2-5
Ore		5-7
Ore, shaly		5
Ore		6
Shale		8
Ore	1 to 1	3 to 8
Shale		

Dip 58° S. 65° E. (overturned) Total ore, including shaly material, 2 feet 9 inches to 4 feet 3 inches.

The seams of ore at the top become much thinner or disappear entirely within a short distance on account of the bed having suffered compression. The quality of the ore appears too variable to be of value. There is much uncertainty as to the correct location of the red ore outcrop in this vicinity. Manuscript maps by C. W. Hayes, which have contributed data on the fault trace, are not in agreement with each other nor with the observations of

the authors, but the negative value of the ore hardly warranted further detailed study.

Two miles northeast of Nicholson Gap where the road crosses the ridge composed of the Red Mountain formation and Fort Payne chert the beds are nearly vertical and strike about N. 35° E., but farther east the Red Mountain beds are overturned and dip southeastward at a steep angle. No ore was noted in this road although there is a section more than 400 feet wide of Red Mountain formation here. A heavy bed of dark ferruginous sandstone, the "big sandy" bed, is exposed in the road and produces much debris in the field above the road at the northeast. Local residents report that ore has been prospected for but that none of value was found. About 1 mile northeast of this road crossing, or 3 miles northeast of Nicholson Gap two deep prospects were dug on the Red Mountain beds 35 to 40 years ago without disclosing anything but red dirt, according to local report. In the SW. cor. sec. 28, T. 8 S., R 7 E., there is an outcrop of red ore 2 feet 6 inches thick (M. II, p. 126).

Morgan Gap.—The following section was measured in 1941 across a series of ferruginous seams interbedded with shale in a ditch along an abandoned part of a local road to Morgan Gap in the southern part of sec. 1, T. 8 S., R. 7 E.

Section of ferruginous seams southeast of Morgan Gap

	Ft.	In.
Shale		
Sandstone, gritty, ferruginous		6.5
Shale, sandy	2	5
Clay, ferruginous with shale streak 5 inches below top	3	2
Shale		2.5
Clay, ferruginous		5
Shale		8
Clay, ferruginous	2	3
Shale, with ferruginous streaks	3	6
Clay, ferruginous		5
Shale, partly altered to limonite		3
Clay, ferruginous		2.5
Shale		2.5
Clay, ferruginous		5
Shale		3
Clay, ferruginous		2
Shale		1.5
Shale, ferruginous at top	1	8
Shale		2
Clay, ferruginous		3
Shale		2.5
Clay, ferruginous		5.5
Shale		3.5
Clay, ferruginous		8
Shale with gritty sandstone		

Dip varies 20° to 28° N. 50° W.
No ore present; ferruginous material too lean to concentrate.

Winston Gap.—At the side of the Winston Gap road in the NE¼ SE¼ sec. 36, T. 7 S., R. 7 E., McCalley (M. II, p. 127) gives a section showing alternations of shale and "ore" in seams of 2 inches to 11 inches thick, in which there is about 2 feet of ore in a total thickness of about 9 feet 6 inches. The following section was observed in 1928. The Red Mountain formation appears to be about 600 feet thick here. (Pl. 6, 8).

Section on road east of Winston Gap

	Ft.	In.
Shale		
Sandstone, reddish, ferruginous		
Shale	12	
Ore, with local thin lenses of shale up to 3 inches thick, about	2	8
Shale, about	2	7
Ore, with shale parting knife edge to 2 inches thick	1	11
Shale, yellow	2	6
Shale, reddish, ferruginous		7
Shale, yellow	2	6
Shale, dark, ferruginous		3-6
Shale, yellow, to "big sandy" seam below	12	

Dip practically vertical, strike about N. 35° E. Total shaly ore, parted by 2 feet 7 inches of shale, 4 feet 7 inches.

At the north side of the road two-fifths mile southeast of the Sand Valley road at Chitwood Gap the "big sandy" seam crops out and 15 feet above it is a siliceous seam having the following section (Pl. 6, 9):

Section of ferruginous seam southeast of Chitwood Gap

	Ft.	In.
Shale		
Sandstone, light brown, ferruginous		7
Shale		4
Sandstone, ferruginous, or very lean ore	1	4
Shale		3
Sandstone, ferruginous, or very lean ore		1[illegible]
Shale		

Dip very steep SE. Total ferruginous sandstone, 2 feet 9 inches.

Along the road to Swindell Gap, 2.2 miles northeast of Chitwood Gap no outcrop of red ore beds could be found, but debris from the "big sandy" seam was seen in a roadside ditch. It was reported locally that no prospects had been made in this district.

The new highway from Fort Payne to Scottsboro is not shown on the Fort Payne topographic sheet, but it crosses strata

of the Red Mountain formation in a gap through which the road to Bootsville Gap formerly ran, 0.8 miles southwest of the Davis Gap road. About 10 feet of ferruginous gritty sandstone crops out in the new road cut, but the ore beds, if present, have been covered by debris, or else have been cut out by a fault. The beds have steep dips to the northwest. The Chattanooga shale crops out about 500 feet to the northwest in normal sequence.

Davis Gap and Gibson Gap.—McCalley, who went over the next 6½ miles northeast of Chitwood Gap in foot, mentions ore showings in sections 30, 20, 16, 9, 10, and 2, Township 7 S., R. 8 E., mostly of a seam 6 inches to 11 inches thick, but in two places he mentions thicknesses of between 1 and 2 feet of ore. (M. II, pp. 128-129) The "big sandy" seam is also mentioned as occurring in this locality, which is on the northwest side of Wills Valley about northwest of Fort Payne.

The strata in the Davis Gap and Gibson Gap roads are vertical and where the shale of the Red Mountain formation is present it is twisted and contorted. No ferruginous beds were noted in these gaps, but about 1 3/4 miles southwest of Gibson Gap (Pl. 6, 10) two ferruginous beds were noted 10 to 12 feet apart. The upper consists of about 7 inches of soft, decomposed, yellow limonite and about 3 feet 9 inches of ferruginous shale. The lower seam contained about 10 inches of soft, ferruginous material of a brownish red color, and of better quality than that in the upper bed. The beds are overturned and dip steeply to the southeast. There were remnants of old prospects here but it was necessary to dig out the debris in order to see the ore. The thicker ore bed resembles somewhat the ore near Dawson (Locality 7, Pl. 5,) mentioned on page 171. The rocks stratigraphically above the ore horizon are in normal relations, the Chattanooga shale being a little below the crest of the ridge.

The Red Mountain formation crops out in a gap through which a local road passes 3.6 miles northeast of Gibson Gap. This is within the area of the map, Plate 7. A ferruginous gritty sandstone (possibly the "big sandy" seam) is indicated in the section by float on the roadside on the southeast side of the ridge, but no red ore beds were seen. The rocks have steep dips to the northwest, and appear to have been faulted.

The ore outcrops to be described in the rest of this part of the report lie within the area of the Stevenson quadrangle. (Plates 7 and 8.) The reconnaissance map of the Stevenson quadrangle is inaccurate in many features as shown by comparison with air photographs. Some of the roads shown on the map have been abandoned or changed, and new roads have been built. The approximate trace of the iron ore is shown on these maps for the sake of uniformity with other areas discussed in this report, and the numbers indicating described localities are located as accurately as the topography will permit. The same locations are shown by section, township, and range on a sketch map compiled from air photos, TVA planimetric maps, and road maps of the Alabama State Highway Department. (Fig. 11).

Southwest, west, and northwest of Valley Head.—In Township 6 S., R. 9 E., McCalley reported ore in sections 19, 9, and 3, with thicknesses of from 3 or 4 inches to 1 foot 4 inches. As evidences of the variability of the same ore seam within a short distance, McCalley cites sections on opposite sides of a test pit 4 feet wide as follows:

Sections on opposite sides of test pit in NW cor. SW¼ SW¼ sec. 9, T. 6 S., R. 9 E.

(M. II, pp. 130-131)

Southwest side of pit	Ft.	In.	Northeast side of pit	Ft.	In.
Shale, dark		0-2	Shale		
Ore		0-2	Ore		0-1
Shale	1	4	Shale	1	
Ore		1-2	Ore		3
Shale		2	Shale		1-2
Ore		3	Ore		4-5
			Shale		2
			Ore		2
Shale, a little ore	1	6	Shale		7
			Ore		1
			Shale		2
	1		Ore		9
Ore		to	Shale		1-2
	1	1	Ore		1-2
Shale		4-8	Shale		4
Ore		1-4	Ore		3
	1	3	Shale	1	6
Shale		to	Ore	streak	
		8	Shale		
Ore	streak				

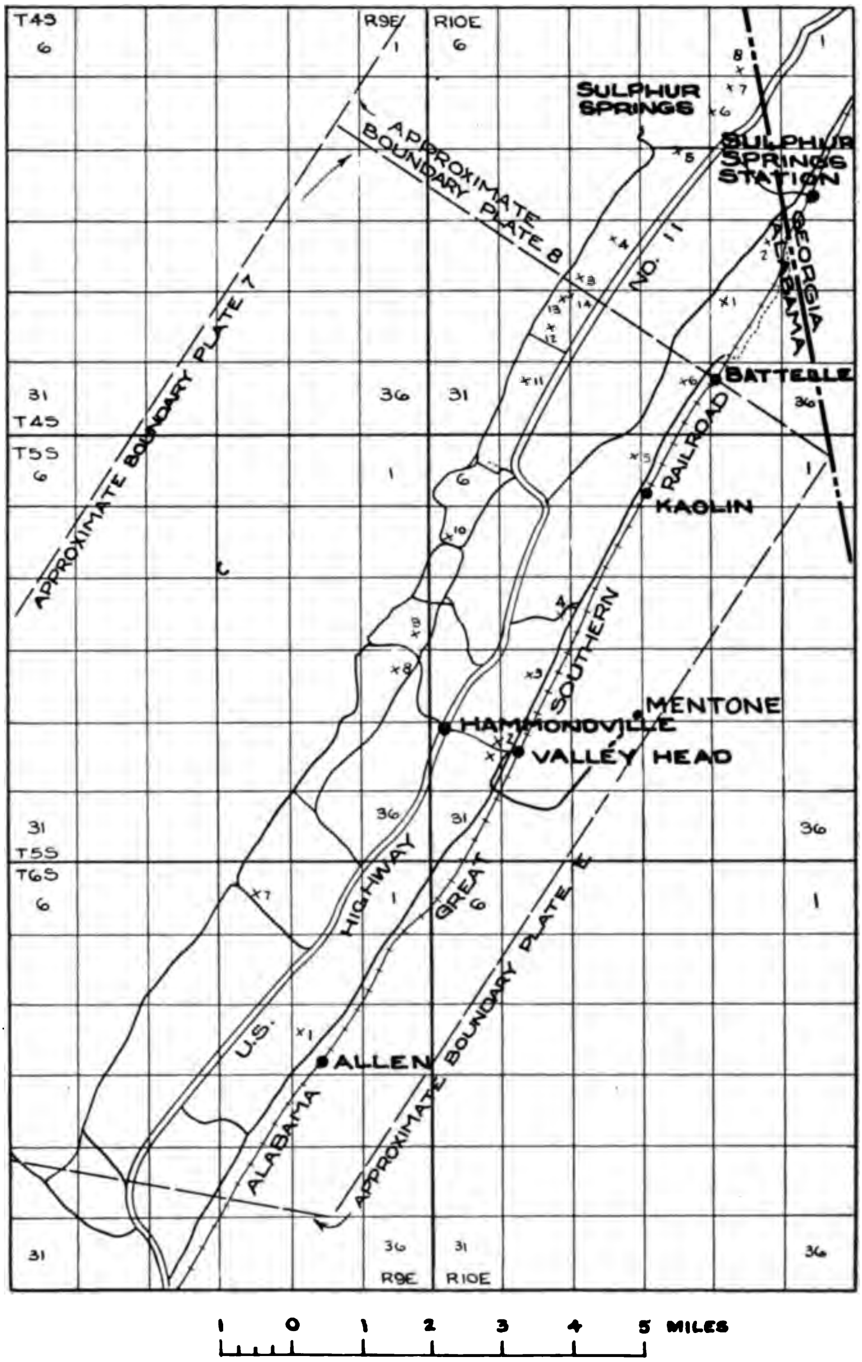

Fig. 11. Sketch map of places prospected for red iron ore in the Valley Head-Sulphur Springs area. Location numbers are identical with those on Plates 7 and 8. Base compiled from TVA Planimetric maps, airplane photographs, and Alabama State Highway maps. Scale 1:125000.

Near the north line of this same Township the following section was recorded:

Section in NW cor. sec. 3, T. 6 S., R. 9 E.

(M. II, p. 131)

	Ft.	In.
Ore, good solid ledge	0 to 1	6 to 4
Shale		1
Ore, resembling limonite		2

Dip about 85° NW.

These seams of ore and shale are so variable that they are not exactly duplicated on opposite sides of the cut, 6 feet wide. The soft ore has good weight and contains a fair proportion of iron. The porous condition of the ore indicates that it was originally a limy ore. The bands of limonite were formed by replacement of shale. A short drift had been driven into the hill on the strike of the ore but had caved down. The "big sandy" ferruginous seam occurs here about 240 feet stratigraphically below, to the southeast, and the Chattanooga shale is about 175 feet stratigraphically above the ore at the prospect. Small float fragments of soft ore, derived from a thin seam associated with a layer of hard limonite occur in several places on the east slope of the ridge in the next 1½ to 2 miles toward the northeast.

In 1939, an old prospect was noted six feet northeast of a local road in the NE¼ of sec. 3, T. 6 S., R. 9 E., about 4 miles southwest of Valley Head. The opening was a trench at right angles to the strike of the beds with a badly caved drift driven on the strike from the trench on the northeast side.

Section of iron-bearing beds in prospect about 4 miles southwest of Valley Head NE¼ of sec. 3, T. 6 S., R. 9 E.

Upper Bench

	Ft.	In.
Shale		
Ore, limonitic, mixed with clay		1½
Shale	1	4
Ore, soft		3
Shale	1	1
Clay, soft, ferruginous		1½
Shale, partly replaced by limonite		1½
Clay, soft, ferruginous		2
Shale, largely replaced by limonite		1
Ore, limonitic, shaly		7½
Ore, mixed with clay, soft, fossiliferous		7

Lower Bench

	Ft.	In.
Shale, including one bed of shaly sandstone	5	2
Clay, soft, ferruginous		4
Shale		8
Ore, soft, limonitic, with clay partings		6-7
Shale		3
Shale	3	6
Clay and limonitic ore mixed		6
Shale		

Dip 75° N. 45° W.
Total ore in upper bench about 1 foot 9½ in.
Total ore in lower bench about 1 foot 3 in.

The Chattanooga shale is exposed in the northeast side of the road 225 feet northwest of the prospect. The shale is in normal position, dips steeply northwest, and is about 96 feet thick.

In the next gap to the northeast, and about 285 feet along the road east of an exposure of Chattanooga shale in a small creek a seam of soft, red ore 8½ inches thick is exposed on the north side of the road. This ore is composed of bright metallic looking oolites cemented together by limonite.

A roadside cut in the northwest ridge just about west of Valley Head showed 1 foot 3 inches of soft, badly disintegrated

ore, possibly a little shaly, with a steep dip northwest. Two other thinner seams were noted 10 feet to 15 feet lower, stratigraphically. Analysis on dried basis of soft ore from this vicinity showed 56.70 percent iron, 10.14 percent insoluble and 0.32 percent phosphorus.

The local road from Valley Head to Pea Ridge crosses the Red Mountain formation 2½ miles northwest of Valley Head. About .3 mile southwest of this road, probably in the NE¼ of sec. 24, T. 5 S., R. 9 E., a prospect trench 130 feet long was made across the ore beds. (Plate 7, 8) As indicated in the section below, a normal fault with a steep dip to the southeast has dropped the beds to the southeast seemingly with a slip of only a few feet. The ore beds vary considerably from the top of the 7-foot trench to the bottom, and there is considerable variation between the two sides which are about 6 feet apart.

Section in prospect about 2½ miles northwest of Valley Head, probably in the NE¼ of sec. 24, T. 5 S., R. 9 E.

	Ft.	In.
Shale		
Clay, ferruginous, and partly altered to limonite		8
Shale	2	7
Ore mixed with shale		2
Shale	3	9
Ore, porous, limonitic, slightly argillaceous	1	2½
Ore, firm, blocky, fossiliferous		3½
Shale		4
Ore, fossiliferous		2
Shale		3
Ore, soft, mixed with clay, with shale parting at top altered to limonite		3
Shale, partly altered to limonite		8
Clay mixed with ore		3
Shale	1	3
Ore mixed with clay		1
Fault		
Shale		6
Clay mixed with ore		4-8
Ore, in thin layers, and including some shale replaced by limonite		4½
Shale		5
Shale, partly replaced by limonite		4
Clay, soft, ferruginous		1
Shale, replaced by limonite		11
Ore, firm, fossiliferous		3
Shale	1	4
Ore, firm, fossiliferous		2
Shale		2
Ore, firm, fossiliferous		2
Shale	1	5
Ore, firm fossiliferous		2½
Shale		2
Clay, mixed with ore		2
Shale	2	5
Ore, firm, fossiliferous		3½
Shale, about	54	
Ore, firm, oolitic, blocky		11
Shale		

Dip 60° N. 60° W. Total ore in about 120 feet of strata 3 feet, 11 inches.

An ore bed which has not been prospected crops out by the side of a store 30 feet northeast of the road to Pea Ridge, but two prospects across the ore beds are located .2 mile northeast of the road in the SE¼ of sec. 13, T. 5 S., R. 9 E. (Plat 7, 9) An opening to the northwest 25 feet long and 15 feet deep is separated by 60 feet of unprospected ground from the southeast opening which is a trench about 75 feet long and 8 feet deep. The rocks are overturned and dip steeply to the southeast.

Prospects in the SE¼ of sec. 13, T. 5 S., R. 9 E.
Northwest opening

	Ft.	In.
Shale		
Shale with thin streaks of limonite		9
Ore, firm, fossiliferous, oolitic, with shale partings		10
Shale		10
Clay, ferruginous		7
Shale	2	
Ore mixed with clay		1-4
Shale	3	4
Ore, soft, mixed with shale		5-6
Shale	6	6
Ore mixed with clay		3

Dip 68° - 75° S. 65° E. Total ore, about 2 feet.

Southeast opening

	Ft.	In.
Shale		
Ore mixed with clay		2-3½
Shale	1	
Ore with shale partings of variable thickness		5-8
Shale	4	8
Ore, fossiliferous, oolitic, with small amount of clay	1	1
Shale and debris		

Dip 75° - 80° S. 65° E. Total ore about 2 feet.

McCalley (II, p. 132) reports in the SE¼ NE¼ sec. 13, T. 5 S., R. 9 E., a section of about 7 feet 6 inches of shale and ore in which there were five seams of ore ranging from 5 inches to 2 feet 6 inches thick, the dip being about 80° northwest. In Township 5 S., R. 10 E., the ore-bearing rocks extend across sections

6 and 7, but are reported to contain ore seams only a few inches to a little more than a foot in thickness.

In a gap of the northwest ridge 2½ to 3 miles northwest of Valley Head and about .7 mile northeast of the local road to Pea Ridge an outcrop of the Chattanooga shale demonstrates the structural deformation common in this area. There are three outcrops of the shale within a distance of 150 feet, the southeast exposure being separated from the middle one by about 100 feet, and the middle one from the northwest exposure by about 35 feet, thus indicating close folding, or duplication by faulting.

The Red Mountain formation is not so well exposed, possibly being partly faulted out, as no indications of ore are shown. The beds are nearly vertical or dip steeply northwest. In the next gap toward the northeast only the upper part of the Red Mountain formation is exposed, showing a little ferruginous sandstone but no ore. The rocks dip steeply northwest.

In the next gap about .9 mile toward the northeast through which passes a little-used road no ore is exposed but in a public road which crosses the ridge diagonally from southeast to northwest just northeast of this gap four ferruginous seams ranging from 4 inches to 10 inches thick are exposed on the southeast slope of the ridge within 55 feet of shale which dips about 65° NW. and strikes N. 22° E. (Pl. 7, 10) The lower three seams are of granular soft ore but the upper one is ferruginous shaly sandstone. McCalley evidently saw the same outcrops, as he mentions the occurrence of four seams in a road on a hill in this locality. He gives a section of the second seam as follows:

Section of ferruginous beds in SE cor. NW¼ SE¼ sec. 7, T. 5 S., R. 10 E.

(M. II, p. 133)

	Ft.	In.
Shale		
Ore		8
Shale	4	
Ore		6

Dip about 85° NW. Total ore 1 foot, 2 inches.

Presumably along the same road Andrews made the following section in March, 1940, just after the road surface had been freshly exposed by a road scraper. (Plate 7, 10) In both directions on the strike are old prospects now practically filled.

Section along road across northwest ridge about 3 miles W. SW. of Kaolin, in sec. 7, T. 5 S., R. 10 E.

	Ft.	In.
Shale		
Ore and shale; ore in seams less than 1 inch thick, badly weathered	1	9
Shale with a few thin layers of sandstone	33	
Shale, ferruginous		1
Shale with thin beds of sandstone	6	
Ore, weathered and mixed with clay		2½
Sandstone interbedded with shale	2	6
Ore, soft, fossiliferous		2
Shale	25	
Ore, soft, oolitic, mixed with clay		9½
Shale with a few thin beds of sand	25	
Ore, mixed with clay		6
Shale		

Dip about 80° N. 60° W.
Total apparent thickness of ore about 1 foot, 8 inches.

Southwest of Sulphur Springs.—At the gap of a branch of Dry Creek west-northwest of Kaolin Station the Red Mountain formation is in place east of the ridge in NE¼ of sec. 6, T. 5 S., R. 10 E. Only the "big sandy" bed of dark ferruginous sandstone is exposed here. About 1.4 miles farther northeast the following section was recorded as observed in two small prospects about 2 feet square (Plate 1, 11):

Section of iron ore bed 3.8 miles southwest of Sulphur Springs NW¼ sec. 32, T. 4 S., R. 10 E.

	Inches
Shale	
Ore, firm, oolitic, fossiliferous	4
Shale, with one or two thin layers of ore	8
Clay, mixed with ore	10

Dip about 55° N., 65° W. Total ore, less than 1 foot.

From the gap of the branch of Dry Creek, mentioned above, northeastward a settlement road was followed in 1928 along the southeast side of Sand Valley, on the northwest slope of the ore-bearing ridge, as far as Sulphur Springs, but no showings of ore were visible. This locality is in Township 4 S., Range 10 E., and the strip of Red Mountain formation crosses sections 32, 29, 28, 21, 16, 15, 10, 11, and 2. McCalley gives sections of the ore as observed in secs. 29, 21, 16, 10 (at Sulphur Springs), and in sec. 11. (M. II, pp. 134-140)

In secs. 29 and 28, which are 2 to 3 miles southwest of Sulphur Springs McCalley records a report that there are three seams of ore with an average thickness of 3 feet, but in only one of his measured sections is there a thickness as great. The following sections give definite thicknesses:

Section of iron ore beds in test pit in SE¼ NE¼ sec. 29, T. 4 S., R. 10 E.
(M. II, 134.)

	Ft.	In.
Shale		
Ore	2	6
Shale, debris	6-8	
Ore	1	6

Section of outcrop in SE¼ NE¼ sec. 29, T. 4 S., R. 10 E.
(M. II, 135)

	Ft.	In.
Shale		
Ore, about	3	2
Ore, shale	1	
Shale		

Dip about 75° N.W.

In March, 1940, Andrews observed a badly caved prospect cut about 4 feet long locally reported to be in the SW¼ NE¼ sec. 29, T. 4 S., R. 10 E., 3 miles SW of Sulphur Springs. (Plate 7, 12) The exposure was poor and showed ore in layers only up to 4 inches thick containing much clay which was being replaced by limonite. The beds strike N. 25° E., dip 20° S. 65° E.

Two other sections also observed in this survey near the above locality are recorded as follows: (Plate 7, 13).

Section of iron ore-bearing beds in NE¼ NE¼ sec. 29, T. 4 S., R. 10 E.
(2.6 miles SW. of Sulphur Springs)

	Ft.	In.
Shale		
Clay, mixed with ore		7
Clay and shale		5
Ore, shaly, fossiliferous, limonitic clay streaks and lenses		5½
Shale	15	
Shale including some soft clay with a little ore	1	6
Ore, firm, fossiliferous, splits into thin scales		5
Shale including two layers of ore less than ½ inch thick	1	
Ore, limonitic	1½	
Clay, mixed with a little ore	6	

Strike N. 45° E., dip about 85° S. 45° E.
Total ore about 1 foot, 6 inches within 20 feet of strata, shown in two small prospects in bank of small creek.

Section of iron ore-bearing beds in NE¼ sec. 29, T. 4 S., R. 10 E.
(2.5 mi. SW of Sulphur Springs)

	Inches
Shale	
Clay	2
Ore, firm, fossiliferous	5
Shale	6
Ore in thin layers, limonitic	8
Clay	4
Shale	

Strike N. 35° E., dip 35° S. 55° E. (in southwest pit).

A total of about 1 foot, 1 inch of ore is shown in two small prospects about 75 feet apart. (Plate 7, 14) In the southwest pit the ore dips to the southeast but in the northeast pit it dips toward the northwest.

In the SW¼ sec. 21, T. 4 S., R. 10 E., 2.2 miles SW of Sulphur Springs there was observed in two small prospects about 200 feet apart on the strike of the rocks a bed 1 foot 4 inches thick containing limonitic, fossiliferous ore in layers having a maximum thickness of 2 inches. The soil cover was heavy and no float ore was seen. The beds are practically vertical and the strike is N. 40° E. (Plate 8, 3).

The lower two of three ore seams in section 21 are reported as follows by McCalley who believed that the upper seam showed elsewhere in the same section of land with a thickness of 3 feet 6 inches.

Section of outcrop in NW¼ NE¼ sec. 21, T. 4 S., R. 10 E.

(M. II, p. 136)

	Ft.	In.
Shale		
Very red soil, probably leads to soft ore		6-8
Ore	1	3
Debris, likely covers shale	8-9	
Shale, visible	4-5	
Ore, good	1	9
Ore, shaly, dark		3-4
Ore, soft, dirty		8-10
Shale, visible	4	

Dip 75° NW.
Total ore, good and poor, about 4 feet.

On the crest of the ore-bearing ridge 1.5 miles southwest of Sulphur Springs in the NE¼, sec. 21, T. 4 S., R. 10 E., Andrews examined several prospects made in 1939. (Plate 8, 4) The largest opening is a trench about 75 feet long and 10 feet deep across the strike of the beds. The ore beds are exposed in a small local anticline about 30 feet across which seems to plunge to the southwest as the apex of the fold crops out 50 feet northeast of the cross-cut trench, and gives a small spread of soft ore at the surface. Other prospect trenches and pits along an ore bed dipping steeply northwest about 25-30 feet to the southwest expose an ore bed similar to the one which crops out in the cross-cut trench. These conditions denote a small syncline parallelling the anticline on the southwest. One or two carloads of soft ore are reported to have been shipped from this locality, but the work has been abandoned due to the high cost of producing the ore. Sections in these cuts follow:

Section of iron ore in cross-cut trench 1.5 miles southwest of Sulphur Springs
Southeast limb of small anticline

	Ft.	In.
Ore, soft, crumbly, argillaceous		7
Shale	2	10
Ore, good, fossiliferous, soft, with a few clay partings		11
Ore with irregular shaly layers		5
Ore, crumbly, argillaceous		10
Clay parting of variable thickness		1-2
Ore, crumbly, soft		3
Shale		

Dip 60° S. 50° E. Total ore, including good and poor, about 3 feet

Section of iron ore 25-30 feet southwest of above section

	Ft.	In.
Shale		
Ore, soft, crumbly, with shale partings		8-10
Clay parting of variable thickness		1-2
Ore, good, firm, granular, fossiliferous		11
Shale, gray		1
Ore, good, soft, crumbly, with one knife edge shale parting		4

Dip 70° N. 55° W. Total ore, 2 feet, 5 inches.

Section of iron ore 100 feet northeast of above section

	Ft.	In.
Shale		
Ore, soft, good, crumbly		10
Shale		

Dip 70° N. 55° W. Total ore, 10 inches.

Two measurements by McCalley in section 16 are as follows:

Section of outcrop in SE. cor. sec. 16, T. 4 S., R. 10 E.
(M. II, p. 136)

	Ft.	In.
Debris, with loose pieces of ore	3-4	
Ore, very red soil		10-12
Shale	1	2
Soil, very red, probably covers soft ore	2	6
Ore, good	1	2
Soil		

Strata are about vertical

Section of outcrop about 50 yards northeast of above section
(M. II, p. 137)

	Ft.	In.
Shale		
Ore, soft, friable, like a sandy loam	1	
Ore, hard, good		6
Shale		1-2
Ore		1-2
Shale		1
Ore, soft, like loam	1	2-3
Shale, ore, mixed		2
Ore, good, soft like loam		8-10
Shale		

Dip about 80° NW.

McCalley (II, p. 137) states that along the wagon road in the SW¼ SW¼ sec. 15, T. 4 S., R. 10 E., there are outcrops of four different seams of ore at considerable distances apart but he gives the thickness of only the lowest one, which was only about 2 inches.

The locations of the numerous prospects near Sulphur Springs in sections 10 and 15, T. 4 S., R. 10 E. cannot be shown adequately on Plate 8 or on Figure 11 because of the small scale of these maps. The locations are shown, therefore, on Figure 12, a larger-scale sketch map of the two sections.

Sulphur Springs.—(Plate 8, 5) About 0.7 mile south of the road to Browns Gap on an old road leading south from Sulphur Springs, the following section in 1939 was measured in a wash on the west side of the road. (Fig. 12, 1)

Section of iron ore in wash .7 mile south of Sulphur Springs NW¼ SW¼ sec. 15, T. 4 S., R. 10 E.

	Ft.	In.
Shale		
Clay mixed with ore		9
Ore, fossiliferous, limy	1	3½
Ore, soft, with thin clay partings		8
Shale		

Dip 75° N. 50° W. Total ore about 2 feet.

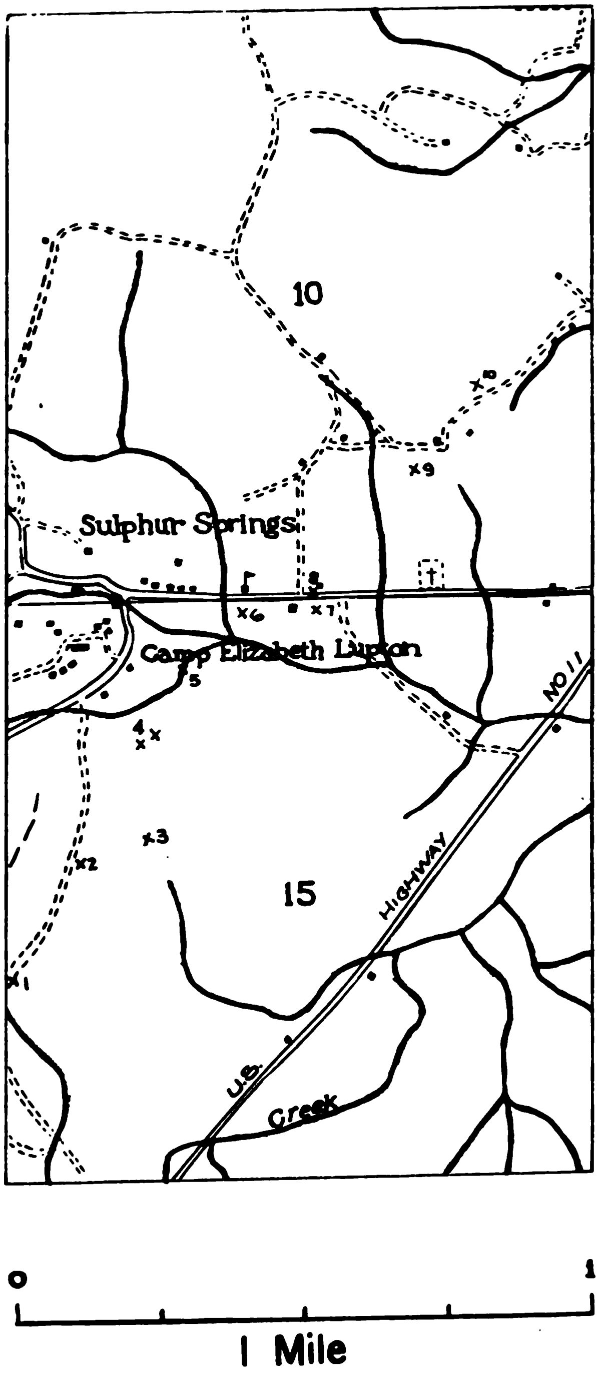

Fig. 12. Sketch map of places prospected for red iron ore in sections 10 and 15, T. 4 S., R. 10 E., near Sulphur Springs. Culture and drainage from TVA Planimetric map No. 101 NE. (Sulphur Springs Quadrangle) Scale 1:24000.

About .2 miles farther north the ore beds crop out in the road and in two prospects on the east side of the road. (Fig. 12, 2) The section is as follows:

Section of iron ore along old road .5 mile south of Sulphur Springs SW¼ NW¼ sec. 15, T. 4 S., R. 10 E.

	Ft.	In.
Shale		
Ore, soft, with thin shale partings		3
Shale		2
Ore, firm, oolitic, fossiliferous		4
Shale		6
Ore, soft		3
Shale	1	3
Ore, soft, mixed with clay, with 4 inch layer of firm fossiliferous ore at top		10
Shale	10	
Ore, hard, oolitic, fossiliferous	1	4
Shale		

Dip 80° N. 50° W. Total ore about 3 feet.

Four tenths of a mile south of Sulphur Springs and about .1 mile east of the old road mentioned above a bed of ore was observed in a small prospect pit. (Fig. 12, 3)

Section of iron ore bed .4 mile south of Sulphur Springs SW¼ NW¼ sec. 15, T. 4 S., R. 10 E.

	Ft.	In.
Shale		
Ore in thin layers, fossiliferous, with shale partings	1	11
Shale		

Dip 80° S. 55° E. Total ore about 1 foot 11 inches.

At Sulphur Springs McCalley (II, 137) enumerates five beds of ore, and gives the following section for the uppermost ore bed in a gully near the schoolhouse:

Section of ore bed at Sulphur Springs
(M. II, 138)

	Ft.	In.
Shale		
Ore, a little shaly, about		8
Shale		3-4
Ore, soft		10
Shale		2
Ore, shaly in places	1	4
Shale		2
Ore, with soft dirty streaks	1	6
Shale	3	6
Shale, ore, principally a curly shale	3	
Shale		

Dip about 45° NW. Total ore, including dirty streaks, about 4 feet 4 inches.

The next lower ore shows in a gully 250 yards southwest of the preceding locality a thickness of 2 feet of good hard limy ore dipping 30° NW; 150 yards to the southeast the next lower bed is reported to comprise 3 feet of good soft ore, and 100 yards southeast of that outcrop the two lowest seams appear as follows:

Section of outcrop on road from Sulphur Springs to Alabama Great Southern Railroad Station
(M. II., 139)

	Ft.	In.
Ore, about	1	6
Debris, shale, about	12	
Ore, about	3	

Dip about 35° NW.

The ore bed is slightly thicker in the vicinity of Sulphur Springs than it is through most of the distance between this place and the vicinity of Littleton, and apparently there had been some digging for soft ore in the vicinity of Sulphur Springs before the time of McCalley's visit. The ore beds at Sulphur Springs were examined in 1911 and 1928, but at neither time was there any mining activity. A section of an ore bed observed in a small creek just south of the road at Sulphur Springs showed the total ore to

be 2 feet 9 inches parted by shale having a total thickness of 1 foot 5 inches. The ore is hard and shows slicken-sides. The dip varies in angle and direction but its general trend is 25° to 40° toward the northwest.

One-fourth mile east of Sulphur Springs on the south side of the main road there are two exposures of ore in a cut separated by about 25 feet of shale. Each seam showed about 2 feet 6 inches of soft, decomposed ore and shale. They may be separate beds or they may be parts of the same bed on opposite limbs of a close fold. In this same road cut a little farther east there is extreme folding of the shale.

Prior to 1941 only a few small prospects had been made at Sulphur Springs, although there are numerous outcrops of ore beds in that vicinity. The attitudes, variable thicknesses, and relative positions of the ore beds indicate duplication by close folding, probably accompanied by faulting.

In 1941 the structure of the rocks in this area was revealed by prospecting two tenths of a mile south of the public road in the SE¼ NW¼ sec. 15, T. 4 S., R. 10 E. (Fig. 12, 4) The openings consisted of three trenches along the strike of the ore beds, a trench 300 feet or more in length across the strike of the beds, and several smaller prospects. The cuts were fresh when visited and small closed folds and small faults could be readily seen in the shale along the shallow cross-cut trench. The ores were reported to occur in pockets, probably produced by local thickening of the beds as a result of folding.

At the southeast a short cross-cut separated from the longer trench by about 35 feet of unexcavated ground showed the following section:

Section of iron ore beds in east cross-cut at Sulphur Springs

Shale	
Ore, soft, upper 3 inches mixed with clay	8
Shale parting	1
Ore, fossiliferous, firm	3½-4
Shale with thin streaks of ore	3½
Ore, with upper 6½ inches mixed with clay	10½
Shale	4
Ore mixed with clay	4
Shale	1
Ore mixed with clay	6
Shale	

Dip 80° N. 48° W. Total ore, good and poor, about 2 feet 8 inches.

The ore beds crop out several times in the long cross-cut trench, which has a total length of about 325 feet. Beginning at the southeast end of the trench the sections are as follows:

Section of iron ore beds 70 feet from east end of cross-cut at Sulphur Springs

	Ft.	In.
Shale		
Clay with ore		5-6
Ore		2
Shale		1
Ore		2-3
Shale		1½
Ore, firm, fossiliferous	1	
Clay mixed with ore		8-9
Shale		3½
Shale with one or two streaks of ore	2	6
Ore mixed with clay		8

Dip 56° S. 45° E. Total ore, good and poor, about 2 feet, 8 inches.

Section of iron ore beds 100 feet from east end of cross-cut at Sulphur Springs

	Ft.	In.
Shale		
Ore, oolitic, fossiliferous		5
Shale with ore streaks		3
Ore mixed with clay		5-6
Ore, firm, fossiliferous		11½
Ore mixed with clay		8
Shale		5
Ore mixed with clay		2-3
Shale	2	3
Ore mixed with clay	1	1

Dip about 40° S. 28° E. Total ore, good and poor, about 3 feet, 10 inches.

Section of iron ore beds 210 feet from east end of cross-cut at Sulphur Springs

	Ft.	In.
Shale		
Ore mixed with clay		6
Shale		1-2
Ore with shale streaks		2-6
Shale		2-3
Ore, good, fossiliferous	1	4
Clay, ferruginous		10
Shale	1	5
Ore mixed with clay		7
Shale		

Dip 50° S. 50° E.
Total ore, good and poor, about 2 feet, 9 inches.

Ten feet beyond the north end of the cross-cut trench a strip trench follows the ore to the southwest, and reveals two beds of ore separated by 12 feet of shale. The beds are not well exposed but each seems to be about 1 foot, 8 inches to 2 feet thick. The two beds in this trench are practically vertical.

The information obtained from examination of these openings shows that there are probably no more than 3 beds of red iron ore in the Red Mountain formation at Sulphur Springs. The beds have been folded into a series of small rolls parallel to the strike, and have been displaced by small faults. Erosion of the disturbed beds has produced the numerous outcrops of red ore beds near Sulphur Springs.

In 1939 the following section was measured on a small creek 600 feet south of the Sulphur Springs road at point where the Creek flows directly north (Fig. 12, 5):

Section of iron ore beds 600 feet south of Sulphur Springs road NE¼ NW¼ sec. 15, T. 4 S., R. 10 E.

	Ft.	In.
Ore, fossiliferous, bright red		4
Shale, gray		8
Ore, hard, fossiliferous		4-6
Shale, gray		4
Ore, soft, shaly		6½
Shale		2
Limestone, gray, fossiliferous		5
Ore, firm		2½
Shale		

Dip 11° S. 70° E. Total ore, about 1 foot, 7 inches.

In 1940 a section was measured of the ore beds exposed in the northwest limb of a small anticline in a brook 25 feet south of the Sulphur Springs road, and seven tenths of a mile west of Highway 11. (Fig. 12, 6)

Section of iron ore beds south of Sulphur Springs road NE¼ NW¼ sec. 15, T. 4 S., R. 10 E.

	Ft.	In.
Shale		
Ore, with interbedded shale and shale lenses	1	10
Ore, shaly		8
Ore, hard, fossiliferous		5
Shale		6
Ore, limy, fossiliferous, dark red		6-8
Shale		6
Ore, oolitic, fossiliferous	1	1
Shale with a few lenses of ore		10
Shale		

Dip about 30° N. 30° W. Total ore about 3 feet.

Eight hundred feet east of the above locality the following measurements were made in a small prospect pit about 100 feet south of the road (Fig. 12, 7):

Section of iron ore beds in prospect south of Sulphur Springs road NW cor. NW¼ NE¼ sec. 15, T. 4 S., R. 10 E.

	Ft.	In.
Shale		
Ore, porous, fossiliferous		5
Ore, fossiliferous, with thin shale partings		3½
Ore, fossiliferous		5½
Shale, gray		3
Ore, fossiliferous		5½
Shale		

Dip 40° N. 70° W. Total ore 1 foot, 7½ inches.

About 100 feet north of the above section the following measurements were made on the north side of the public road. (Fig. 12, 8)

Section of iron ore beds .6 mile west of Highway 11 SW. corner of SE¼ sec. 11 T. 4 S., R. 10 E.

	Ft.	In.
Shale		
Clay mixed with ore		3
Shale		5
Clay mixed with ore		6
Ore, fossiliferous, oolitic, with clay lenses		4
Shale		2
Ore, fossiliferous, with shale partings	1	
Shale		3
Ore mixed with clay		2-3
Shale		2½
Ore mixed with clay		2½
Shale		3
Ore mixed with clay		3
Shale	2	6
Ore, soft		6
Shale		1
Ore mixed with clay		2-4½
Shale		

Dip 65° N. 55° W. Total ore, good and poor, about 3 feet, 6 inches.

Northeast of Sulphur Springs.—In 1940 the following section was measured in a prospect pit two tenths of a mile north of the cemetery at Sulphur Springs. (Fig. 12, 9)

Section of iron ore-bearing bed .2 mile north of Sulphur Springs cemetery

	Ft.	In.
Shale		
Ore	1	1
Shale		3
Ore	1	1
Shale		

Dip 55° N. 50° W. Total ore 2 feet, 2 inches.

The rolls responsible for the numerous outcrops of ore beds in the vicinity of Sulphur Springs die out to the northeast, and the rocks dip northwest. About .65 mile northeast of the village Andrews measured the following section in 1941. (Fig. 12, 10) The ore beds are exposed in two small prospect pits which lie about 35 feet to the southeast of an old prospect trench. The trench was traved several hundred yards northeastward but the ore bed was hidden by debris.

Section of iron ore beds about .65 mile northeast of Sulphur Springs

	Ft.	In.
Shale		
Ore and clay mixed; section contains 2 definite seams of ore about 2 inches thick	1	10
Unexcavated interval about	18	
Ore, argillaceous		6½
Shale		
Ore with clay		1½
Shale		

Dip about 35° N. 55° W. Total ore not more than 1 foot.

Three-fourths of a mile northeast of Sulphur Springs in an old prospect the following section was measured: (Pl. 8, 6):

Section of iron ore bed three-fourths mile northeast of Sulphur Springs

	Ft.	In.
Shale		
Ore, soft, dark red granular, of good quality with thin lens of shale near middle	1	5
Shale		1
Ore		8
Shale		1
Ore		8
Shale		

Dip 50° N. 55° W. Total ore, about 2 feet 9 inches.

About one fourth mile farther northeast in an old prospect a bed of ore 2 feet 6 inches to 2 feet 8 inches thick is disclosed, dipping about 50° N. 55° W. The ore is soft and red and includes two or three thin shale partings. Several openings toward the northeast showed from 2 feet 6 inches to 3 feet of soft ore containing shale partings and in places many fossils such as **Pentamerus** and **Streptelasma.**

About 1.5 miles northeast of Sulphur Springs (Plate 8, 7) a new prospect made in 1941 showed the following section:

Section of iron ore bed 1.5 miles northeast of Sulphur Springs

	Ft.	In.
Shale		
Ore, soft		6
Shale, about	10	
Ore, soft; with clay lenses		9
Ore and clay mixed		3
Shale		1
Ore, soft, fossiliferous		7
Shale, about	3	
Ore, soft		4

Dip 42° N. 45° W. Total ore in approximately 15 feet of strata: 2 feet, 5 inches.

In June, 1941, a seam of soft red ore, 1 foot, 6 inches to 1 foot 8 inches thick, was being mined in Alabama 1½ miles north of Sulphur Springs and about ½ mile southwest of the Alabama-

Georgia State line. (Fig. 11, 7) The ore was excavated by hand from a trench on the outcrop south of the Red River Branch of Dry Creek, and was obtained in large angular lumps and blocks. The ore crops out on the eastern slope of the West Red Mountain ridge, strikes about N. 30° E., and dips normally about 45° toward the northwest. The ore is fairly free from shale except a few thin streaks at the top of the bed. It was reported to range from 50 per cent to 56.4 per cent in iron, 0.16 to 0.8 per cent in manganese, and up to 0.4 per cent phosphorus. It was skidded down to the base of the hill by horse power, hauled by truck to the Alabama Great Southern Railroad and shipped to the Sloss-Sheffield blast furnaces at Birmingham. At that time the price of ore of this grade at the furnace was 6 cents per unit per ton for ore carrying 50 per cent of iron, 6½ cents for 53 per cent iron, and 7 cents for 55 per cent and more of iron. This operation seems to represent the latest mining activity on the northwest strip of red iron ore in Wills Valley.

About 1¾ miles northeast of Sulphur Springs, or just within Alabama near the Georgia line, a prospect on the ridge about 100 feet above creek level shows the following section (Pl. 8, 8):

Section of iron ore bed 1 3/4 miles northeast of Sulphur Springs

	Ft.	In.
Shale		
Ore, shaly		4
Shale		2
Ore, soft, dark red, granular, with argillaceous streaks; a few fossils	1	6
Shale		1
Ore		8
Shale		

Dip 50° N. 55° W. Total ore, 2 feet 6 inches.

Beginning on the northeast side of the local road on the northeast side of Red River branch of Dry Creek in the SE¼ SW¼ sec. 2, T. 4 S., R. 10 E., the ore bed mentioned in the paragraph above was prospected in 1940 for several hundred feet northwestward along the strike. (Fig. 11, 8) Measurements made from place to place showed a range in thickness from 1 foot 2

inches to 1 foot 9 inches. The ore is firm, fossiliferous, and soft, and contains a few clay lenses. The beds dip 46° N. 50° W. The thinner beds mentioned in the section above were not prospected. Four cars of ore are reported to have been shipped from this place in 1940, and the last car is reported to have shown on analysis about 57 percent of iron.

McCalley (M. II, 139) also notes some of the old diggings between Sulphur Springs and the Georgia line in which thicknesses of 2 to 4 feet were reported, but wherever a good thickness occurred there were partings of shale in the ore as in th next section. The prospect was probably in section 10 instead of section 11 as given by McCalley, as the SE¼ of section 11 is southeast of the ore outcrop according to recent maps.

Some of these old diggings for soft ore extended for a quarter of a mile along the outcrop and the ore bed was also worked beyond the State line in Georgia. The blast furnaces nearest to this locality were those at Battelle, Alabama, and Rising Fawn, Georgia, both of which ceased operations 30 or more years ago.

Pudding Ridge.—(Plate 8) About 6 miles north of Sulphur Springs, Alabama, and 6½ miles southwest of Trenton, Georgia, on the axis and near the head of an anticline that plunges gently southwest below Sand Mountain there is exposed an area of Red Mountain formation a quarter to half a mile wide and approximately 2 miles long, about 1 mile of which is in Alabama. This anticline is generally parallel to and about 4 miles northwest of the Wills Valley anticline which terminates in Johnson Crook, in Georgia, and the two structures overlap for a few miles in an **en echelon** pattern. The Red Mountain strata lie on the west slope and spurs of Pudding Ridge which is on the east side of Crawfish Creek, a tributary of Lookout Creek. The Red Mountain formation is bordered by Chattanooga shale and Fort Payne chert and the dips are generally moderate to the northwest and southeast. The anticlinal structure produces a U-shaped outcrop, the strip on the west being the longer. The outcrops in Alabama are in sections 10 and 15, T. 3 S., R. 10 E. Several prospects were examined which showed hard ore that was 2 feet 6 inches to about 3 feet thick exclusive of a few thin shale partings.

The following eight sections were measured on Pudding Ridge in Alabama:

Section of iron ore bed in east limb of anticline on Pudding Ridge near the State line (Pl. 8, 9)

	Ft.	In.
Shale		
Ore, containing rusty argillaceous knots and streaks in upper part		10-11
Shale		2-3
Ore, with many streaks of lime carbonate, nearly	2	

Dip very slight S. 60° E. Total ore, about 2 ft. 10 in.

This ore was measured in a prospect in a steep gully about 150 feet below the crest of the ridge and 150 feet above Crawfish Creek and consequently rather difficult of access. This ledge crops out for a quarter to half a mile southwest and shows its full thickness in many hollows. At the southwest extremity of the outcrop the ore bed swings around to the west and northwest in the chain of foothills of Sand Mountain. There appear also to be thin seams of ore in places 20 feet to 30 feet below and above the main ore bed.

Section of iron ore bed in SE¼ NW¼ sec. 10, T. 3 S., R. 10 E., on Pudding Ridge

	Ft.	In.
Shale		
Ore, weathered, with shale streak 1 to 2 in. thick near middle	2	
Shale		

Dip 8° - 9° N. 65° W.

Section of iron ore bed cropping out on west side of creek in SE¼ NW¼ sec. 10, T. 3 S., R. 10 E.

	Ft.	In.
Shale		
Ore, hard, calcareous, fossiliferous, with 1 inch shale seam in upper part	2	7

Dip 12½° N. 60° W.

Drilling with a hand drill is reported to have shown ore 3 feet thick including a thin parting of shale. Analysis of the drilling which was in hard ore was reported as follows:

	Per cent
Fe	33.25
SiO_2	5.30
$CaCO_3$	35.00
(CaO	19.60)

Section of iron ore bed near State line on Pudding Ridge probably in NE¼ sec. 10, T. 3 S., R. 10 E.

	Ft.	In.
Shale		
Ore, hard, with thin seam of shale in upper part	2	5

Dip 9° - 10° N. 70° W.

Section of iron ore bed near southern end of anticline on Pudding Ridge (Pl. 8, 10)

	Ft.	In.
Shale		
Ore, hard, with lenses and streaks of shale near top and middle	2	1
Shale		4
Ore, calcareous	1	

Dip 9° SE. Total ore, 3 feet 1 inch.

It was reported that the hard ore from this prospect, which is near creek level, averages nearly 30 per cent iron, about 22 per cent lime, and about 3 per cent silica.

Section of iron ore bed in east limb of anticline, on Pudding Ridge about a quarter of a mile southwest of the State line

	Ft.	In.
Shale		
Ore, hard, granular and fossiliferous, contains a few limy streaks and argillaceous knots	1	11
Shale		2
Ore, softer than upper bench	1	
Total ore, 2 feet, 11 inches.		

Bed lies nearly horizontal.

This section is shown in a prospect in a hollow tributary to Crawfish Creek. The ore appears to be of good quality.

Section of iron ore bed in NW¼ NE¼ sec. 15, T. 3 S., R. 10 E., on west limb of Pudding Ridge anticline

	Ft.	In.
Shale		
Ore, hard, calcareous in places, contains large cup corals and brachiopods in certain layers	2	11

Dip 9° N. 65° - 70° W.

Section of iron ore bed on right bank of small branch of Crawfish Creek, about one-fifth mile southwest of State line (Pl. 8, 11)

	Ft.	In.
Shale		
Ore, hard, calcareous, granular and fossiliferous with a few nodules of argillaceous material		11
Shale		1
Ore, similar to above	1	6
Shale		

Dip 11° - 15° N. 65° W. Total ore, 2 feet 5 inches.

McCalley gives the following section of an outcrop near the Georgia line that shows about 2 feet of hard, limy ore:

Section of iron ore in NW¼ sec. 10, T. 3 S., R. 10 E.
(M. II, p. 140)

	Ft.	In.
Debris		
Ore, good, hard or limy		6
Loam		3-4
Ore, good, hard or limy	1	6
Debris, most likely covering shales	20	
Ore, good, hard or limy		5

Dip 25° to 30° NW.

McCalley (II, p. 140) also states that an ore seam about 3 feet thick crops out near the center of sec. 15, T. 3 S., R. 10 E. He mentions Deer Head Cove in this connection but the topographic and geologic maps of the Stevenson quadrangle show that Deer Head Cove lies between Pudding Ridge and Fox Mountain and that the strata are of Bangor limestone which lie stratigraphically considerably higher than the Red Mountain formation. The Red Mountain beds are exposed in the lower part of Deer Head Cove in Georgia about half a mile beyond the State line.

The ore in the Alabama portion of Pudding Ridge appears to consist of only one seam of possibly workable thickness. The hard ore is leaner than is acceptable for present day requirements, but as there is a considerable spread of ore in this locality lying with gentle dips well above the valley level, it is possible that sufficient ore may be present to warrant future interest. Results of careful examination and sampling of the Pudding Ridge properties in Georgia and Alabama as summarized in a professional report[1] show that some of the ore carries as little as 18 per cent metallic iron and some as high as 35 per cent; that low iron is always accompanied by high lime; that silica and alumina are generally low, and that an average analysis of the hard ore would be approximately as follows:

Average analysis of Pudding Ridge hard red iron ore

	Per cent
Iron (Fe)	27.50
Silica (SiO_2)	6.00
Alumina (Al_2O_3)	2.50
Lime and magnesia ($CaO - MgO$)	27.50
Phosphorus (P)	0.40

If worked, the Alabama ore will have to be mined in connection with its northeastward extension in Georgia. A spur track from the Alabama Great Southern Railroad up Crawfish Creek for 2½ to 5 miles would reach most of this ore-bearing area. Ore of this thickness and character obviously must be susceptible to cheap mining and transportation in order to warrant its use. In view of the development of mechanical methods of underground mining and loading the ore of the Birmingham district, which ranges from 7 to 12 feet thick, it is a question whether the mining cost per unit of iron here could be brought as low as in that district. Twenty years ago there might have been a slight difference in favor of Pudding Ridge. If cheap transportation is to be achieved notwithstanding the increased freight rates of recent years the ore cannot be shipped far from the mines—probably no farther than Chattanooga, Tennessee, or Gadsden, Alabama.

[1]Porter, John Jermain, private report to owners of property, 1911.

Resume of Iron Ore Reserves in Wills Valley, Northwest Side

[illegible] occupies [illegible] Ridge besides the [illegible] between [illegible] and Sul- [illegible]. The average thickness [illegible] to be about [illegible] feet. The average width of [illegible] because [illegible] outcrop. [illegible] the estimated quantity of re- [illegible] and [illegible] appears to be approxi- mately [illegible] long tons.

SHINBONE RIDGE

Plates [illegible]

Shinbone Ridge is the narrow foothill ridge that lies south- east of Lookout Mountain in Alabama, separated from the moun- tain [illegible] by a narrow valley. The greatest height of the ridge above the lowlands of Coosa River is about [illegible] feet near Gadsden, but near [illegible] Shinbone Ridge prac- tically disappears, due to structural deformations of the rocks, and [illegible] it is only a line of very low hills. Shin- bone Ridge [illegible] Etowah and Cherokee Counties; the south- western [illegible] the Gadsden quadrangle and the remainder [illegible] northeastward to the Alabama-Georgia line is within the Fort Payne quadrangle. The total length of outcrop of Red Mountain formation along Shinbone Ridge in Alabama is more than [illegible].

The rocks that form Shinbone Ridge are, in their normal ascending sequence, the Chickamauga limestone which lies along the southeastern base of the ridge, the shale, sandstone, and fer- ruginous beds of the Red Mountain formation which form the southeastern slope and extend nearly to or beyond the crest, the black Chattanooga shale, the Tuscumbia limestone and Fort Payne chert which lie on the northwest slope. The Hartselle sandstone and the Bangor limestone form the northwest base of the ridge and the floor of the valley between the ridge and Lookout Moun- tain. The rocks in the Coosa Valley east of Shinbone Ridge are

the limestone and shale of the Conasauga formation and the cherty Copper Ridge dolomite. Variations from this sequence have been produced by faults which in places cut out some of these rocks. The direction of the ridge practically coincides with the strike of the beds. The beds dip at moderate to steep angles toward the northwest and are also vertical or overturned throughout some of their extent.

A geological section across Shinbone Ridge, Lookout Mountain and Red Mountain a few miles northeast of Gadsden and Attalla would show the ore-bearing beds of the Red Mountain formation presumably extending from their outcrop in Shinbone ridge beneath Owl Valley, Lookout Mountain, and Little Wills Valley to come to the surface in Red Mountain, thus forming a broad synclinal basin rather sharply upturned, and probably more or less faulted in or below Shinbone Ridge, on the southeast edge. Nothing is actually known, however, of the extent or nature of the red ore beds for more than a few hundred feet down their dip. Efforts to reach them by drilling in Owl Valley, west of Shinbone Ridge, are reported to have been unsuccessful and a drill hole, southeast of Crudup (p. 121) showed the ore to have become thinner. In December 1946, drilling of a new hole near the mouth of Owl Valley at an angle of 45° toward Shinbone Ridge was begun under the direction of the U. S. Bureau of Mines. Deep drilling in the Lookout Mountain plateau will be the only certain means of demonstrating whether there are beds of coal and iron ore of commercial quality and thickness below this area.

The Lookout Mountain syncline is terminated at its southwest end by an extensive east-west fault which brings the shale and limestone of the Conasauga formation into contact with the Pennsylvanian rocks and which may have here a displacement of as much as 6500 feet.[1] The trace of this fault from Gadsden to west of Attalla is marked by the escarpment of Lookout Mountain and by the abrupt terminations of Shinbone Ridge and Red Mountain.

Beginning at the east-west fault at Gadsden and extending northeastward the ore bed of the Red Mountain formation that crops out in Shinbone Ridge shows a variable but progressive

[1]McCalley, Henry, Op. cit., p. 31.

mined out to the surface. The old strip pits, 15 to 30 feet below and to the southeast of the crest, are more or less continuous to the south end of the ridge. Many pieces of well-leached, rich iron ore, predominantingly of the fine, flaxseed grained type remain to indicate the type of ore mined near the surface. The ore is fractured and slickensided showing movement of the beds. The crest of the ridge in this locality is formed by beds of hard sandstone of the Red Mountain formation in a vertical position or slightly overturned to the southeast.

The largest mine in this group was No. 3, situated about 1¾ miles from the south end of the ridge. A tunnel goes into the southeast slope of the ridge in the direction N. 52° W. for about 400 feet where it intersects the bed of ore. A slope is driven down the ore bed on its strike, about S. 25° W. at an inclination of 15° to 22°. The ore bed dips 75° to 78° toward the northwest. At the top of the slope the ore measured 2 feet 9 inches thick in addition to 9 inches of ferruginous shale on the hanging wall, which usually comes down with the ore, but is easily separated from it. The footwall is hard, sandy shale. Mining was discontinued in September, 1926, but the mine was kept pumped out until September, 1928, when the pumps were withdrawn so that in October of that year the workings could not be entered. The workings were reported by the watchman to consist of the slope and 5 working levels driven from it at intervals of 100 feet vertically. The underground length is reported to be about 1 mile. The ore was brought up the slope in cars by cable and trammed out through the tunnel by mules. The ore was dumped into a pocket on a trestle between the hillside and the railroad track, fed on a short metal belt conveyor where shale was picked out. The ore was crushed to about 4 inch size and went directly down a chute into railroad cars. A standard guage railroad spur connecting with the Southern Railway track near Gadsden terminated at this mine, but an old abandoned grade extends about 1.85 miles farther northeast along the southeast base of the ridge.

The ore and overlying shale are very fossiliferous; many calcareous corals (Zaphrentis) are present, also flattened argillaceous nodules. Some of these nodules show distortion produced by squeezing when the beds were tilted.

Analyses of ore produced in 1910-1912 from the Hammond and Etowah mines are as follows:

Analyses of iron ore from Hammond and Etowah mines[a]

Mine	Fe	SiO_2	Al_2O_3	CaO	Mn	P	H_2O
Hammond	37.54	11.19	5.38	14.51	.11	.37	1.80
Hammond	36.94	12.82	5.41	13.44	....	....	.90
Hammond	40.35	9.20	4.82	12.58	....	.44	1.00
Hammond	36.14	11.89	4.88	14.03	....	.50	
Hammond	32.02	18.80	8.04	18.88		....	
Etowah	41.67	6.92	3.49	14.99			

a--Authority, Standard Steel Co.

Analyses of the ore mined during the last period of activity show that at the 400-foot level a hard ore occurs containing more than 41 per cent iron, about 12 per cent insoluble and 18 to 19 per cent lime carbonate (10 to 10.6 per cent lime oxide). Except for the phosphorus content this is a comparatively high grade of hard ore.

Analyses of iron ore from Etowah mines at vertical depth of about 400 feet.

	Fe	SiO_2	Al_2O_3	Insol.	$CaCO_3$	P
January, 1926	41.79	7.60	4.90	12.30		0.48
February, 1926	41.86	7.50	4.53	11.18		0.46
March, 1926	41.57	7.50	4.46	11.58	18.98	0.51
May, 1926	41.57	8.6	4.48	12.36	17.78	0.43

[1]Sloss-Sheffield Steel and Iron Co.

Northeastward from Etowah No. 3 are several old prospect tunnels above the line of the old railroad grade. About 1 mile northeast of No. 3 a tunnel is driven N. 45° W. into rocks dipping 50° toward the northwest. (Pl. 4, 8) There was some ore in pieces 4 inches thick and much shale on the dump. Near the end of the old grade a tunnel about 90 feet below the crest of the ridge is driven about 200 feet into beds of shaly sandstone dipping N. 52° W. At the face of this tunnel in rocks dipping about 72° NW. was a seam of ferruginous shale, not an ore. This pros-

pect seems to have missed the real bed of ore, because in a small pit about 75 feet higher on the ridge is exposed a seam of ore 1 foot 1 inch thick with 9 inches of ferruginous shale overlying it. The dip here is 62° N. 45° W. At the crest of the ridge is hard sandstone standing nearly vertical. This point is opposite the brickyards of Agricola & Co. in the valley west of Shinbone Ridge.

From the end of the old railroad grade northeastward along Shinbone Ridge to the Citico mine, a distance of about 4 miles, there has been more or less prospecting for ore and for some distances in several places are traces of old trenches from which surface ore was evidently dug and hauled down the ridge in wagons. The ore along here is predominantly interlayered with shale, so that in mining it must have been necessary to sort out the ore by hand. The two following sections indicate the character of the ore bed in this vicinity (Pl. 4, 9):

Section of iron ore bed on Shinbone Ridge about 4 miles N. E. of Gadsden

	Ft.	In.
Shale		
Ore, soft, good		5
Shale		2½
Ore, good		3
Ore, mixed with shale		9
Ore, good		2½
Ore, good with shale		2½
Shale	1	10
Ore, good		2½
Shale	6	
Dip 50° NW.		

Total ore, including shaly portions, 2 feet ½ inch.

Section of iron ore bed $1\frac{1}{4}$ miles W. of Citico mine on east side of Shinbone Ridge, 100 ft. below crest

	Ft.	In.
Shale		
Ore, soft		3
Shale		2
Ore		10
Shale		1
Ore	1	6
Shale	2	
Ore		$2\frac{1}{2}$
Shale		$1\frac{1}{2}$
Ore		$1\frac{1}{2}$
Shale	7	
Sandstone	12	
Dip 25° NW.		

Total ore, 2 ft. 11 in.

Citico mine.—The Citico mine (Pl. 4, 10) on the west slope of Shinbone Ridge about 7 miles northeast of Gadsden is the next place where large scale mining has been carried on. Idle for many years, in October, 1928, the workings were filled with water and the tunnel was more or less caved. The ore-bed was reached by a cross-cut tunnel driven approximately S. 40° E., into shaly sandstone dipping 33° N. 40° W. and forming the west slope of the ridge. Sections made when the mine was in operation showed the ore bed to range between 2 feet 4 inches and 3 feet thick. These sections showed the quality of the ore to vary considerably owing to the presence of iron pyrites, seams of shale, and nodules of argillaceous rock. The ore in the lower workings was high in calcium carbonate and notably fossiliferous. (See Figs. 7, 8A, and 8B). This mine was formerly operated by Chattanooga, Tennessee, parties who utilized the ore in the former Citico blast furnace at that place, but later it was reported to be the property of the Sloss-Sheffield Steel and Iron Co. The following sections indicate the character of the iron ore bed 25 to 50 ft. northeast of the lower cross cut:

Section of iron ore bed in main haulway of Citico mine

	Ft.	In.
Shale		
Shale, hard limy		2
Ore, hard limy		11
Shale		2
Ore		6
Shale		8
Ore		1
Shale		2
Ore		10
Shale		

Dip, 30° N. 50° W.

Total ore, 2 ft. 4 in.

Section of iron ore bed in main haulway of Citico mine

	Ft.	In.
Shale		
Shale, tight to top		1-2
Ore, hard		10
Shale		1
Ore, hard and limy with kidneys of shale		9
Shale		5½
Ore and shale mixed, about 2/3 ore in streaks 1-2½ in. thick	1	5
Shale		

Dip 30° N. 40° W.

Total ore, about 2 ft. 6 in.

Section of iron ore bed in main haulway of Citico mine, about 50 *ft. northeast of lower cross cut*

	Ft.	In.
Shale		
Shale, hard, frozen to ore		2
Ore, hard, limy		8½
Shale		1½-2
Ore, good		9
Shale		3-4
Ore		5
Shale		3
Ore		2
Shale		1
Ore		3
Shale		½
Ore, hard, limy		2½
Shale		½
Ore		4
Shale		

Dip 30° N. 40° W.

Total ore, 2 ft. 10 in.

Section of iron ore bed in main haulway of Citico mine at left of upper crosscut

	Ft.	In.
Shale		
Shale, tight to ore		2-3
Ore, hard, limy		11
Shale		1
Ore, with shale streaks in base		5
Shale		½
Ore		2
Shale		5
Ore		3
Shale and a little ore		5
Ore		1½
Shale		½
Ore and shale kidneys		4
Shale		1
Ore, soft with kidneys and streaks of shale		9
Shale, hard, limy		
Dip 32° N. 40° W.		

Total ore, including shaly material and kidneys 2 ft. 11½ in.

One set of analyses of hard ore produced from the Citico mine in 1911 show rather low iron and slightly high alumina (cf. first five analyses) whereas the next two are of better grade ore and the eighth is of soft ore:

Analyses of iron ore from Citico mine on Shinbone Ridge

Ore	Authority[1]	Fe	SiO_2	Al_2O_3	CaO	Mn	P	H_2O
Hard	S	32.24	15.94	5.08	17.48			1.3
Hard	S	32.72	16.18	5.32	16.24			2.2
Hard	S	33.69	15.76	4.98	15.94			2.6
Hard	S	31.72	16.86	5.41	16.51			2.6
Hard	S	34.72	15.28	4.92	15.70			1.3
Semihard	C	38.07	10.24	4.17	14.38	0.14	0.38	
Semihard	C	38.50	13.16	......	12.75			
Soft	C	54.87	8.05					

[1]S, Sloss-Sheffield Steel and Iron Co.
C, Citico Blast Furnace Co.

Turkeytown.—About 1½ miles northeast of the Citico mine Shinbone Ridge is cut by a creek that rises in Owl Valley and

flows out to Coosa River, passing the settlement called Turkeytown. On the south side of the gap of the ridge (Pl. 4, 11), are some prospects in the ore bed, said to have been made by the Alabama Consolidated Coal and Iron Co. A small tunnel about 25 feet above the creek has been driven in on the strike of the ore bed about S. 23° W. The beds dip here 25° to 35° about N. 52° W. The ore bed contains much shale, one parting being as thick as the total ferruginous material. The following section shows the character of the ore in this locality:

Section of iron ore bed on south side of gap in Shinbone Ridge 1/3 mile west of Turkeytown

	Ft.	In.
Shale		
Ore, soft, good		3½
Shale	1	9
Ore, good		9
Ore, dirty		3
Shale		7
Ore, poor, dirty		6
Shale, ferruginous		2
Shale		
Dip 30° NW.		

Total ore, including poor portions, 1 ft. 9½ in.

Northeastward from the gap near Turkeytown the bed of ore is thinner than southwest of this gap. Although thicknesses of 2 feet or more have been reported from place to place, the following measured sections do not support the hope that ore 2 feet or more in thickness is present except in restricted localities. In such places it could be considered of commercial importance only where a good body of soft ore lies under thin cover and with dip favorable for stripping. A prospect pit on the southeast slope of Shinbone Ridge about 1-3/5 miles northeast of the gap near Turkeytown, and 1 mile west of the place shown as Oak Hill on the topographic map of the Fort Payne quadrangle disclosed the following section. (Pl. 4, 12) This pit was about 200 feet southeast of the crest of the ridge.

Section of iron ore bed about 1 mile west of Oak Hill

	Ft.	In.
Shale		
Ore, soft		4
Shale	1	4
Ore, good		8
Ore, dirty		2
Shale		
Dip 40° NW.		
Total ore, 1 ft. 2 in.		

Slackland.—Southwest of Slackland the ore in Shinbone Ridge is less than 1 foot thick as shown by the next two sections. (Pl. 4, 13 and 14):

Section of iron ore bed 1 mile north of Oak Hill

	Ft.	In.
Shale		
Ore, soft, good		9
Shale	2	10
Sandstone	1	3
Dip 42° NW.		
Total ore, 9 in.		

Section of iron ore bed in Shinbone Ridge about 1 mile SW. of Slackland

	Ft.	In.
Shale		
Ore, soft, sandy		3
Shale	4	
Ore, poor		2
Shale		3
Ore, good		3
Shale	1	
Sandstone		10
Dip 45° NW.		
Total ore, 8 in.		

A few notes and sections on the ore beds in the Red Mountain formation on Shinbone Ridge have been given by McCalley[1] which are of interest in comparison with the more recent observations and which also tend to indicate the noncommercial nature of the beds of ore along most of the ridge northeast of Turkey-

[1] McCalley, Henry, Report on the Valley Regions of Alabama, Part II, Coosa Valley Region: Geological Survey of Alabama, 1897, pp. 796-809.

town. Those sections taken from McCalley are indicated by the credit note (M. II, p. ......)

The following section was noted by McCalley of an ore bed that had been prospected in the gap through the ridge near the Etowah-Cherokee County line:

Section of iron ore bed in NW¼ of SW¼ of sec. 19, T. 10 S. R. 8 E., about 1 mile southwest of Slackland
(M. II, p. 799)

	Ft.	In.
(5) Debris, sandstone		
(4) Ore; good, compact	1	6
(3) Shale; dirt		1-2
(2) Ore		5
(1) Shale, sandstone		
Total ore, 1 ft. 11 in.		

McCalley also states that the ore in the NE¼ sec. 19, T. 10 S., R. 8 E., was said to be 1 foot 4 inches to 1 foot 6 inches thick. In the same vicinity J. R. Ryan observed three seams of ore separated by respectively 45 feet and 7 feet of shale, as in the following section:

Section of iron-bearing portion of Red Mountain formation in gap of Shinbone Ridge one-half mile N. W. of Slackland

	Ft.	In.
Shale		
Ore[a]		4
Shale	45	
Ore[a]		5
Shale	1	6
Ore[a]	1	7
Shale	7	
Ore[a]	1	4
Shale		9
Ore[a]		6
Shale		4
Ore[a]		3
Shale	2	9
Ore[a]	1	
Shale		
Dip vertical		

Total ore: Bottom seam, 3 ft. 1 in.; middle seam, 2 ft.; Top seam, 4 in.

[a]Decomposed to ferruginous sand; not a commercial ore.

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Bristow.—Northeast from the Etowah-Cherokee County line Shinbone Ridge has been reduced by erosion to a line of low knolls and the red iron ore is not well exposed until a point about 1 mile southwest of Bristow is reached, where the following section of iron-bearing beds was measured (Pl. 9, 1):

Section of iron-bearing portion of Red Mountain formation 1 mile southwest of Bristow

	Ft.	In.
Ore[a]		9
Shale	6	
Ore[a]	1	
Shale	12	
Ore[a]		4
Shale	7	
Ore[a]	1	6
Shale	1	5
Ore[a]		8
Shale	1	
Ore[a]		6
Sandstone		

[a]Decomposed to sand.

Dip 55° SE.

Total ore: Bottom seam, 1 foot 8 inches; second seam, 4 inches; third seam, 1 foot; top seam, 9 inches.

About one-quarter mile southeast of Bristow several sandy, ferruginous strata, that can hardly be called iron ore, separated by considerable thicknesses of shale are exposed in the Center-Collinsville road, according to the following section (Pl. 9, 2):

Section of iron-bearing portion of Red Mountain formation one-quarter mile southwest of Bristow

	Ft.	In.
Shale		
Ore, soft, good		5
Shale	18	
Ore, poor, sandy		6½
Shale	46	
Ore, poor, sandy		1
Shale		9
Ore, poor, sandy		10
Shale	1	1
Ore, poor, sandy		3
Shale		6
Ore; poor, sandy		2
Shale	12	
Ore		1
Shale		3
Ore		2
Sandstone		

Dip 65° SE.

Total ore: Bottom seam, 3 inches; second seam, 1 foot, 4 inches; third seam, 6½ inches; top seam, 5 inches, or 2 feet 6½ inches of poor, sandy ore within 81 feet 1½ inches of the formation.

This ferruginous material, locally known as the "big sandy seam", was observed by McCalley in the NW¼ sec. 2, T. 10 S., R. 8 E. (Pl. 9, near locality 2)

The next place at which ore was noted is about 2 miles northeast of Bristow, where a seam of good soft ore 5 inches thick, is interstratified with shale dipping 37° toward the northwest. (Pl. 9, 3). About 3 miles northeast of Bristow the strip of Red Mountain formation is terminated abruptly against a fault along which for a distance of 2½ miles, or to near Starling Gap, the Cambrian or Ordovician dolomite is in contact with the Pottsville formation. A thin seam of ore, parted by shale, is exposed about one-half mile southwest of Yellow Creek (Pl. 9, 4):

Section of iron ore bed one-half mile southwest of Yellow Creek, 3 miles northeast of Bristow

	Ft.	In.
Shale		
Ore, soft, good		5
Shale		2
Ore		2
Shale		

Dip 40° NW.

Total ore, 7 in.

Firestone.—Little River emerges from the Lookout Mountain plateau at Firestone and cuts through the strip of Red Mountain formation which is here in its normal sequence. No iron ore is exposed in this strip of the formation near the river because the surface is low, but in a ridge beginning at the bank of a small creek one-half mile northeast of the river (Pl. 9, 5) a prospect tunnel was driven many years ago into iron-bearing beds. The tunnel follows the strike of the beds about N. 35° E. for 85 feet in beds that dip about 80° toward the southeast. From the tunnel the beds have been stoped upward 10 feet or more and some soft ore is reported to have been mined and shipped to Chattanooga. Several seams of soft, granular ore, none more than a few inches in thickness, were found here, but the material carries such a large proportion of shale that it can be of no commercial value. The beds have been much disturbed and seem to have been faulted at the mouth of the tunnel. On the top of the hill above the tunnel two prospects were noted on the trace of the ore-bearing beds and fragments of sandy fossiliferous ore were found partly altered to limonite.

The following section was measured by J. R. Ryan at the mouth of the prospect:

Section of iron-bearing beds one-half mile north of Little River on north bank of creek

	Ft.	In.
Shale		
Ore, soft, good		3
Ore, shaly		10
Shale		2
Ore, shaly		1
Ore, good		2
Ore, shaly	1	
Ore, good		2
Shale		1
Ore, good		2
Ore, shaly		½
Ore, good		3
Shale		

Dip 80° E.

Total ore: good, 1 foot

Total ore: shaly, 1 foot 11½ inches

Beginning north of Firestone and extending northeastward to beyond Taff, a distance of 5 or 6 miles, a fault, in which the Copper Ridge dolomite is brought up against rocks of the Red Mountain formation borders the iron-bearing formation on the southeast and may have submerged the ore seams in places. The disturbed condition of the rocks at the above described prospect is due to this fault.

Congo.—The next locality toward the northeast to be noted was at an old tunnel about one-half mile southwest of Congo where the following section was measured (Pl. 10, 1):

Section of iron-bearing beds one-half mile southwest of Congo

	Ft.	In.
Shale		
Ore, soft, poor, sandy		1
Shale		2
Ore, poor, sandy		1½
Shale		3
Ore, good		3
Shale		2
Ore, mediocre		10
Shale		

Dip 75° SE.
Total ore, 1 ft. 3½ in.

At the side of a small creek three-quarters of a mile northeast of Loop, the following section of ore-bearing material has been recorded (Pl. 10, 2):

Section of iron ore bed three fourths mile northeast of Loop, 250 feet southwest of a small creek

	Ft.	In.
Shale		
Ore, soft, good		3
Shale		6
Ore, with shale streaks		3
Ore, poor, contains shale		4
Shale		2½
Ore, mediocre		3
Shale		

Dip 45° toward SE.
Total ore, mostly poor grade, 1 ft. 1 in.

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About half a mile northeast of Taff in a cut of the road to Menlo a small seam of ore was observed. (Pl. 10, 3)

Section of iron ore bed one-half mile northeast of Taff

	Ft.	In.
Shale		
Ore, soft, poor, dirty		4
Shale		2
Ore, medium grade		3
Shale		

Dip 25° SE.

Total ore, 7 in.

Blanche.—About three-quarters mile southwest of Blanche on the highway about 1500 feet northeast of a small creek (Pl. 10, 4) the following section across about 90 feet of the iron-bearing portion of the Red Mountain formation was measured by Ryan. On the basis of division by beds of shale there appear to be about 8 ferruginous horizons here mostly containing poor, sandy ore, or ferruginous sandstone, and in fact there are only about 10 inches of good ore recorded in the whole section of more than 90 feet of the formation.

Section of ferruginous beds of Red Mountain formation three-quarters mile southwest of Blanche

	Ft.	In.
Shale		
Ore, soft, poor, dirty		1½
Shale		1
Ore, poor, dirty		2
Shale	3	
Ore, good		2
Shale	36	
Ore, poor, dirty		2½
Shale		3
Ore, poor, sandy		8
Shale		3
Ore, hard, poor, sandy	1	
Shale	2	10
Ore, hard, poor, sandy		5
Shale	1	11
Ore, soft, poor, sandy		3
Shale	1	11

Ore, soft, poor, sandy		2
Shale	2	5
Ore, poor, sandy		5
Shale		2
Ore, hard, poor, sandy		2
Shale		1
Ore, poor, sandy		3
Shale		2
Ore, poor, sandy		5
Shale		1
Ore, poor, sandy		3
Shale		9
Ore, poor, sandy		3
Shale	2	
Ore, poor, sandy		3
Shale		5
Ore, hard, poor, sandy		4½
Shale		6
Ore, poor		2
Shale		2
Ore, poor, sandy		4
Shale		5
Ore, poor, sandy		10
Shale	5	
Ore, soft, poor, dirty		1
Shale	4	
Ore, poor, hard, sandy	1	3
Shale		2
Shale, poor, hard, sandy		2
Shale		4
Ore, poor, sandy		3
Shale		1
Ore, poor, sandy		2
Shale		7
Ore, poor, sandy		4
Shale	18	
Ore, good		8
Shale		

Dip vertical

About one-quarter mile southwest of Blanche (Pl. 10, 5) another section was made across some of the iron-bearing measures, but according to the following record very little good iron ore was shown. A curious belief held by some persons to the effect that where a number of thin seams of iron ore are distributed through a great thickness of shale eventually these iron ore seams will come together and form one valuable seam has not been

verified in the observation of the writers. In some places where an ore bed of valuable thickness is parted by thin seams of shale the shale has been observed to disappear locally, and thus in a sense the separated iron ore seams come close together. Both ore and shale commonly form thin lenticular sheets.

Section of ferruginous beds of Red Mountain formation one-quarter mile southwest of Blanche

	Ft.	In.
Shale		
Ore, soft		4½
Shale	25	
Ore, sandy, poor		5
Shale	1	6
Ore, poor, sandy	1	8
Shale		7
Ore, poor, sandy		4
Shale	4	
Ore, poor, sandy		3
Shale	3	
Ore, poor, sandy	1	3
Shale	2	5
Ore, poor, sandy	2	3
Shale		2
Ore, poor, sandy		4
Shale	20	
Ore, good		2
Shale		2
Ore, good		5
Shale	33	
Ore, poor, dirty		4
Shale		

Dip 52° toward NW.

Total ore, mostly very low grade, 6 feet, 9½ inches within about 94 feet of the formation. Only 7 inches of good ore noted in two seams.

About one mile northeast of Blanche on the south bank of a small branch a cut reported to have been made by Fort Payne parties shows the following section (Pl. 10, 6):

Section of iron ore bed 1 mile northeast of Blanche

	Ft.	In.
Shale		
Ore, soft, good	1	6
Shale parting		1
Ore, medium grade		2½
Shale, mixed with ore		8½
Shale		
Beds nearly vertical		
Total ore, about 2 feet		

A new trench made in 1941 along the outcrop of the ore bed about 1½ miles northeast of Blanche showed the following section:

Section of iron ore bed 1½ miles northeast of Blanche

	Ft.	In.
Shale		
Ore, soft, fossiliferous	1	
Ore, thin bed with clay streaks and lenses; some shale streaks replaced by limonite		10
Shale		
Dip 78° N. 40° W. Total ore 1 foot, 10 inches		

Jamestown.—About one mile southwest of Jamestown in an old prospect cut the following section was observed (Pl. 10, 7):

Section of iron ore bed 1 mile southwest of Jamestown

	Ft.	In.
Shale		
Ore, soft, dirty		2
Shale parting		6
Ore, good		8
Shale, mixed with ore		2
Ore, good		1½
Shale, mixed with ore		3
Ore, good		1
Shale, mixed with ore		7
Shale		
Dip 78° NW.		
Total ore, including shaly material, about 2 feet.		

On Shinbone Ridge just east of Jamestown McCalley noted the following section:

Section of iron ore bed near Jamestown in NE¼ of SW¼ of sec. 27, T. 7 S., R. 10 E.
(M. II, p. 797)

	Ft.	In.
(5) Shale		
(4) Ore		2
(3) Shale, ore; ore in thin streaks		8
(2) Ore	1	
(1) Shale		
Total ore, 1 foot, 2 inches		

McCalley also notes a number of thin seams or streaks of ore at Ebenezer Church in the SE¼ SE¼ sec. 28 (?), T. 7 S., R. 10 E. totaling about 1 foot of good ore within more than 60 feet of the Red Mountain formation.

On Shinbone Ridge (Pl. 10, 8) about a mile northeast of Jamestown, Ryan measured a portion of the Red Mountain formation containing 11 thin seams of ferruginous material, the details of which are as follows:

Section of iron ore-bearing portion of Red Mountain formation 1 mile northwest of Jamestown

	Ft.	In.
Ore, soft, good		1½
Shale	23	
Ore, soft, good		2½
Shale	8	
Ore, soft, good		1
Shale	14	
Ore, soft, dirty, poor		2
Shale	8	
Shale mixed with a little ore	3	6
Ore, good		5
Shale	40	
Ore, sandy, poor		5
Shale	45	
Ore, sandy, poor	1	2
Shale	12	
Ore, dirty, poor		2
Shale	10	
Ore, soft, good		5
Shale	3	
Ore, dirty, poor		2
Shale	4	

Ore, dirty, poor		3
Shale		
Dip 65° NW.		
Total ore 2 ft. 7 in. in about 175 feet of the formation.		

One mile farther northeast on Shinbone Ridge the following section of what Ryan termed "seam 5" was measured (Pl. 10, 9):

Section of seam 5 of iron ore 2 miles northeast of Jamestown

	Ft.	In.
Shale		
Ore, soft, good		2
Ore, mixed with shale		5
Ore, good		4
Shale		6
Ore, good		4½
Shale		
Dip 35° NW.		
Total ore, about 1 foot.		

About 1 mile farther northeast a measurement of ore was recorded by McCalley as follows:

Section of iron ore bed in southeast corner NW¼ sec. 13, T. 7 S., R. 10 E. — three miles northeast of Jamestown
(M. II, p. 797)

	Ft.	In.
(4) Shale, visible	3	
(3) Shale and ore mixed	1	4
(2) Ore, good, maximum		10
(1) Shale		
Total ore, about 1 foot		

Chesterfield.—In the dirt road about 200 yards northeast of Chesterfield Ryan measured the following section of ore-bearing material (Pl. 10, 10):

Section of ore bed 200 yards northeast of Chesterfield

	Ft.	In.
Shale		
Ore, soft		2
Shale parting		2
Ore, dirty		4
Shale parting	1	
Ore, poor, sandy		11
Shale		
Dip 78° NW.		
Total ore, 1 ft. 5 in.		

About 1 mile north of Chesterfield Ryan measured the following section in the Red Mountain formation in which there are 5 horizons of iron ore separated by major thicknesses of shale. One of the ore "seams" was itself parted by shale and for the most part the observed ore was an impure variety (Pl. 10, 11):

Section of ferruginous beds in Red Mountain formation 1 mile northeast of Chesterfield

	Ft.	In.
Shale		
Ore, soft		1
Shale	10	
Ore, dirty		2
Shale	7	
Ore, dirty		3
Shale	10	
Ore, dirty		2
Ore, mixed with shale		2
Shale	5	
Ore, mixed with shale		3
Shale		6
Ore, dirty		3
Shale		

Dip 35° NW.

Total ore, 1 ft. 4 in. within about 35 feet of formation

One and one-half miles northeast of Chesterfield or about three-quarters mile southwest of the Alabama-Georgia line the following section shows thin seams of iron ore at two horizons separated by 45 feet of shale (Pl. 10, 12):

Section of ferruginous beds in Red Mountain formation 1½ miles northeast of Chesterfield

	Ft.	In.
Seam 6:		
Shale		
Ore, soft good		8
Shale	45	
Seam 7:		
Ore, soft, good		3
Shale parting		3
Ore, good		5
Shale		

Dip 40° NW.

Total ore, 1 ft. 4 in. in two seams in more than 45 feet of formation.

The ore bed continues northeastward in Shinbone Ridge into Georgia. It is less than a foot thick near the State line but increases to about 3 feet thick in places in Georgia where it has been mined along the outcrop.

Resume of iron ore reserves in Shinbone Ridge

The approximate length of outcrop of iron ore beds 2 feet or more thick in Shinbone Ridge from Gadsden northeastward to the Alabama-Georgia State line is about 8 miles, or 42,240 feet. The average width down the dip of workable ore is placed at 1,000 feet, which is far from reaching the escarpment of Lookout Mountain but it may include some hard ore. The average thickness of the ore bed appears to be 2.6 feet, although near Gadsden it is, of course, much thicker, as at the Etowah mines. The estimated total quantity of recoverable soft, semihard, and hard ore appears to be approximately 7,779,000 long tons, which is between the totals of the Greasy Cove and Springville areas.

East of Shinbone Ridge

(Plates 4, 9, and 10)

Round Mountain.—Round Mountain (Plate 9, 11) is a small isolated hill on the Southern Railway about 5 miles west of the town of Cedar Bluff and 3 miles southwest of Tucker Ridge. The hill rises about 400 feet above the level of the Coosa Valley. It is on the northwest side of the great fault that borders the southwestern part of Tucker Ridge and is a remnant of one of the blocks of Red Mountain strata that are scattered from place to place along this fault.

The Red Mountain formation here contained a bed of iron ore that was mined since the early 1850's in order to supply a small cold blast charcoal furnace that stood at the foot of the hill. The easily available ore has apparently been practically all mined out.

The Round Mountain furnace was one of the earliest in northeastern Alabama and had an interesting history. Ethel Armes[1] writes that in Michael Tuomey's report is the following letter from Moses Stroup, builder of the furnace, dated at Round Mountain Furnace, March 18, 1855:—

"Round Mountain was first put in operation in April, 1852, and has been in operation most of the time since. It has produced two and one half tons metal per day, and consumed on an average of six hundred fifty bushels of charcoal per day. A portion of the metal is converted into hollow ware and machinery, which is sold in this State, the balance is run into pigs, which find a market in Georgia. The ore used is the red fossiliferous kind. It is taken from the side of the mountain, very near the furnace, where it lies in strata from ten to twenty-four inches in thickness; and is delivered at top of furnace at sixty cents per ton. This ore, when properly treated, makes the best quality of iron for castings and foundry pig.

"The furnace is thirty-two feet high, eight feet in the boshes, and driven by steam power, the steam generated by

[1]Armes, Ethel, The story of coal and iron in Alabama: University Press, Cambridge, Mass., 1910, p. 66. (See also pp. 96, 163, 183, 186, 195, and 320.)
The original reference, in Tuomey's second report, 1858, p. 29, differs a little from this.

the waste heat of the furnace, blown by a cold blast. The number of hands employed for all purposes connected with the furnace is forty-five. It is over half a mile from the Coosa River, on which is shipped the pig iron to Rome, Georgia. There is an abundance of good limestone within a mile of the furnace."

In 1855 Stroup sold the Round Mountain plant to P. S. Marshall, of Eddyville, Ky., from whom it passed into the hands of Captain J. M. Elliott of Rome, Ga., in 1857, who rebuilt and enlarged it. It was destroyed in the Civil War, but again rebuilt by Captain Elliott who organized the Round Mountain Coal and Iron Company in 1870. At this time the capacity of the furnace was increased from 7 to 25 tons of pig iron per day. It made high-grade chilling iron, used mainly for car wheels, rails, and rolls of rolling mills. This iron had a wide market, being shipped as far as Pittsburgh, Pa., but after the building of the Elliott car works at Gadsden furnished the iron for that plant. Interesting data and photographs are published by Woodward.[1] By-products were calcium acetate and wood alcohol.

At the then abandoned mines of the Round Mountain Iron and Wood Alcohol Co., more than 50 openings were observed by the senior author in 1906, but most of them had caved down covering the ore bed. There may be two thin beds of ore represented here but the openings noted seemed all to be on one bed. This bed consists of two thin benches of ore separated by shale; the upper is coarse grained, well leached, soft, altered to some extent to limonite, and contains many fossils such as corals and brachiopods, but the lower bench is harder, has a bright metallic luster, and contains fewer fossils. The total thickness of ore in the bed varies from 1 foot to 3 feet 2 inches. The block of Red Mountain formation has been badly broken up and the dips of the ore bed are diverse, varying from 14° S. 60° E. to 45° N. 30° E. Several measured ore sections are given below:

[1]Woodward, Joseph H., II., Op. cit., pp. 116-119.

Section of iron ore in tunnel extending northward just south of Round Mountain Furnace

	Ft.	In.
Shale		
Ore, soft		6 to 1
Shale		8 to 1
Ore, hard	1 to 1	2

Dip 14° S. 60° E.

Total ore, 1 ft. 6 in. to 2 ft. 2 in.

On the north side of Spring Hollow the ore bed is very irregular in thickness. It was said to reach a maximum of 3 feet in places and to squeeze down to 1 foot within a short distance.

Sections of iron ore in tunnel on north side Spring Hollow, Round Mountain

	Ft.	In.
I		
Shale		
Ore	1	0
Shale		
II		
Shale		
Ore with shale streaks near top	1	9
Shale		
III		
Shale		
Ore, with shale streak near top	1	4
Shale		

Dip 18° S. 60° E.

Total ore from 1 ft. to 1 ft. 9 in.

Sections of iron ore beds in Whitt opening, Round Mountain

	Ft.	In.
I		
Shale		
Ore, soft	1	2
Shale, ferruginous	1	3
Ore, hard	1	5

II

Shale		
Ore, soft, good quality	1	6
Shale		8
Ore		4
Shale		1
Ore		6-7
Shale		2
Ore		9
Shale		

Dip 35° to 45° N. 25° to 30° E.

Total ore from 2 ft. 7 in. to 3 ft. 2 in.

Section of iron ore beds in Hamilton Tunnel

	Ft.	In.
Shale		
Ore, soft		6
Shale		8
Ore, soft		4
Shale	2	
Ore		4
Shale	2	
Ore, hard	1	2
Shale		

Dip 5° to 10° N. 85° E.

Total ore, 2 ft. 4 in.

In addition, the following sections have been published by McCalley, who found there one seam of ore in two benches. McCalley locates Round Mountain in section 33 but the recent geologic map of Alabama shows the area of Red Mountain formation to be in section 28, T. 9 S., R. 9 E.

Section of iron ore bed at Ford Bank on southwest side of Round Mountain, in NW¼ of NW¼ sec. 33, T. 9 S., R. 9 E.

(M. II, p. 800)

	Ft.	In.
Shale		
Ore, soft, upper bench		6
Shale, ore	1	
Shale, yellowish	1	6
Ore, lower bench, reported 2 ft. in places, (visible)	1	2
Sandstone		

Total ore, 1 ft. 8 in.

Section of iron ore bed at mouth of drift at southeast foot of Round Mountain near furnace in SE¼ NW¼ sec. 33, T. 9 S., R. 9 E.
(M. II, p. 801)

	Ft.	In.
Shale		
Ore, soft, good, upper bench	1	6
Shale, ore		8
Shale	1	4
Ore } lower bench		5-6
Shale } lower bench		1
Ore } lower bench		5-6
Soft, black, sandy material being mined		2
Sandstone		

Dip, 30° SE. Total ore, about 2 ft. 7 in.

Section of iron ore bed on southeast side of Round Mountain
(M. II, p. 801)

	Ft.	In.
Shale		
Ore, good, upper bench		9
Shale, ore	1	1
Shale, gray	1	3
Ore		2
Shale		1 to 2
Ore	2	3
Sandstone		

Total ore, 3 ft. 2 in.

Section of iron ore bed higher on southeast side Round Mountain
(M. II, p. 801)

	Ft.	In.
Shale, visible	10	
Ore, good, soft, upper bench		8
Shale, ore	1	2 to 3
Shale, gray	1	
Ore		1 to 2
Shale		2
Ore		4
Shale		4 to 5
Ore	1	
Soft, black, sandy material with a little ore in places, being mined		5 to 6
Sandstone		

Total ore, about 2 ft. 7 in.

[illegible]

[illegible]

[illegible]

[illegible] Mountain Plate 4 [illegible] — [illegible]

[illegible] of the [illegible] and the [illegible] the full

thickness of the soft ore in the bed, analyzed on a dry basis, showed iron, 58.94 percent; silica, 7.496 percent, and phosphorus, 0.393 percent. This seam of ore was reported in 1928 to have been trenched on the outcrop for soft ore that was sent to a blast furnace many years ago. The hill is less than a mile long and the ore-bearing rocks are cut off by the fault on the southeast so that the area holds no promise as a reserve of more ore for blast furnace use. The high percentage of iron in this ore suggests, however, its availability as an ingredient in metallic paint. While in Gadsden in 1929 one of the authors was shown a specimen of very rich red hematite that had been compressed so as to produce slickensides and incipient metamorphism and consequent enrichment in iron oxide. This ore was said to have come from this locality near Coosa River, and appeared to have been derived from a place where the ore bed had been squeezed and fractured by earth movement induced by the thrust faulting. The quality of the specimen appeared excellent for paint material.

Tucker Ridge (Dirtseller Mountain)

(Plates 9 and 10)

Three to six miles southeast of Shinbone Ridge and extending from near the confluence of Little and Chattooga Rivers northeastward into Georgia is an unsymmetrical synclinal area having a total length of about 17 miles and a maximum width of about 3 miles. Rocks of the Red Mountain formation form the border of this syncline except where they are cut out by a fault for about 2 miles northeast of Gaylesville. The Red Mountain beds have gentle southeast dips and a wide area of outcrop on the northwest limb of the syncline, Tucker Ridge, proper, as named on the topographic map of the Fort Payne quadrangle. Northeast of Mill Creek they are exposed all the way across the Dirtseller Mountain syncline so as to form the floor of Panther Creek valley. This latter portion of the area is shown on the topographic map of the Rome quadrangle.

Prior to 1910 there was considerable iron ore mining activity in the Dirtseller Mountain part of the area in Georgia,[1] where railroad connections were available, but the ore bed was mined also to some extent in Alabama and the ore hauled to the Southern Railroad near Cedar Bluff.

Description of the iron ore outcrops.

Along the southeast slope of Tucker Ridge the bed of iron ore ranges between 6 inches and 2 feet 2 inches in thickness and in most places is parted by thin seams of shale. It dips generally 15° to 30° SE., and the moderately dipping areas have afforded good advantages for mining soft ore by stripping along the outcrop. On the southeast limb of the syncline near Mills Creek the bed contains 1 foot to 1 foot 10 inches of ore, dipping 45° to 48° NW. During the period of mining, mostly prior to 1910, the ore was removed in many places practically to the limit of profitable mining at that time. It is possible that some small areas of soft ore still remain unmined, but if not the deposits can hardly be considered of commercial value under present conditions because the hard ore would be too thin to warrant underground operations, and possibly also too lean in iron.

Gaylesville.—The Red Mountain formation on the southeast limb of the Dirtseller syncline southwest of Gaylesville forms a narrow hook-shaped area pointing northeast but does not extend far northeast of Gaylesville and is partly cut off to the southeast by two faults, as shown on the geologic map of Alabama. McCalley has noted a seam of compact, fossiliferous good ore that showed a thickness of 6 inches, about 4 miles west of Gaylesville in the SE¼ SE¼ sec. 18, T. 9 S., R. 10 E., and in a ravine in the adjoining section of land he measured the following outcrop:

Section of part of Red Mountain formation in the SW¼ of SW¼ of sec. 17, T. 9 S., R. 10 E., or about 3¼ miles southwest of Gaylesville
(M. II, p. 803)

	Ft.
Sandstone, massive and flaggy, near	100
Shale	60
Ore, very fine quality, about vertical, nearly	1
Shale, visible, some	75
Total ore, 1 foot.	

[1]Burchard, Ernest F., Red Iron Ores of East Tennessee, Northeast Alabama, and Northwest Georgia: U. S. Geol. Survey Bull. 540, 1913, p. 314.

Sections of iron ore in Tucker Ridge will be given beginning at the southwest end. These were nearly all measured by J. R. Ryan and some were verified by the authors in subsequent visits to the field. About 300 yards from the southwest end of the ridge in a branch on the southeast side of the ridge there are two seams of ore separated by 16 feet of shale in the following relations (Pl. 9, 6):

Section of iron ore-bearing beds near southwest end of Tucker Ridge, 5½ miles southwest of Gaylesville

	Ft.	In.
Upper, or 1st seam:		
Shale		
Ore, mixed with shale		2
Ore, good		2
Shale		1
Ore, good		2¾
Shale		½
Ore, poor		1
Ore, mixed with shale		9
Shale	16	
2nd seam:		
Ore, soft		4½
Shale		

Dip 35° SE.

Total ore, including shaly material, 1 ft. 4¾ in. in upper seam and 4½ in. in lower seam, separated by 16 ft. of shale.

The next section toward the northeast probably represents the lower of the two seams noted above (Pl. 9, 7):

Section of iron ore bed 5 miles west-southwest of Gaylesville

	Ft.	In.
Shale		
Ore, soft		5½
Shale		

Dip from 6° to 8° SE.

Total ore, 5½ in.

In the next section toward the northeast stated by Ryan to be in the western part of Tucker Ridge the bed of ore shows less than 1 foot in thickness; the location is not at all definite:

Section of iron ore-bearing bed 4½ miles west-southwest of Gaylesville

(Pl. 9, 8)

	Ft.	In.
Shale		
Ore, soft		5
Shale		2
Ore, very sandy		4
Sandstone		

Dip 10° to 12° SE. Total ore, 9 in.

The next section is apparently in the strip of Red Mountain formation that extends east from Tucker Ridge toward Gaylesville. The prospect is reported to be on a creek branch above the Gaylesville-Round Mountain road.

Section 3¾ miles west-southwest of Gaylesville, Ala.

(Pl. 9, 9)

	Ft.	In.
Shale		
Ore, soft, porous, coarse grained, good quality		9
Shale		

Dip 20° NW. Total ore, 9 in.

The next section is reported by Ryan to be in Harden Narrows, 200 yards north of Chattooga River, about 50 yards south of the crest of the ridge in a prospect shaft. This place cannot be located definitely in the area of either Plate 9 or Plate 10.

Section of iron ore bed 3¼ miles west of Gaylesville

	Ft.	In.
Shale		
Ore, soft		4
Shale		2
Ore		3
Shale		1
Ore		2½
Shale		

Dip 78° NW. Total ore 9½ in.

The next section was measured by Ryan in Pucketts Gap (Pl. 9, 10), near the Cedar Bluff-Fort Payne road. This is in the main part of Tucker Ridge.

Section of iron ore bed 2¾ miles west of Gaylesville

	Ft.	In.
Shale		
Ore, soft, sandy		2
Shale		11
Ore		4
Shale		2½
Ore		2
Shale		1
Ore		1
Shale		

Dip 18° to 20° SE. Total ore, 9 in.

The next section was measured in a cut made in 1907 by the Southern Iron and Steel Company about 2 miles west of Gaylesville (Pl. 10, 13):

Section of iron ore-bearing beds 2 miles west of Gaylesville

	Ft.	In.
Shale		
Ore, soft		2
Shale		11
Ore, mixed with sand		2
Shale		8
Sandy ore		1
Shale		3½
Sandy ore		1½
Shale	1	2
Ore, good		2
Shale		½
Ore, good		2
Shale		2
Ore		1½
Shale		

Dip 20° to 22° SE. Total ore, including sandy portions, 12 inches, within a section of 4 feet, 3 inches of beds.

The next section is similar in character (Pl. 10, 14) It was observed in a cut reported to have been made by the Alabama Steel and Wire Co. about 1900. Southward for about three-quarters mile the ore is apparently only a ferruginous sandstone.

Section of iron ore bed 1.7 miles west-northwest of Gaylesville

	Ft.	In.
Shale		
Sandstone, ferruginous		2
Shale		3
Sandstone, ferruginous		2
Shale		11½
Ore, soft, good		5
Shale		1½
Ore		1½
Shale and ore mixed		5
Shale		

Dip about 20° SE. Total ore, including shaly portion, 11½ in.

McCalley observed the following two sections, the first one of which is in the gap through which the Gaylesville-Fort Payne road crosses Tucker Ridge (Pl. 10, 15). The full thickness of the ore as worked here many years ago was reported to McCalley to average 2 feet 6 inches.

Section of iron ore bed in NW¼ of sec. 3, T. 9 S., R. 10 E.

	Ft.	In.
Shale		
Sandstone merging into ore below	1	1
Ore, very good	1	1
Shale	1	
Ore, good visible to a depth of		5

Total ore, about 1 ft. 6 in.

The next section was about half a mile northeast of the preceding section:

Section of iron ore bed in NW¼ of sec. 3, T. 9 S., R. 10 E.
(M. II, p. 804)

	In.
Shale, sandstone (more or less ferruginous)	
Ore, sandy in places	5
Shale, reported to be only in places	5
Ore, good	11
Clay, visible	2
Debris, may hide some ore	

Total ore, 1 ft. 4 in.

Analyses given by McCalley (M. II, p. 804) show the main constituents for the upper 5 inches (1) and the lower 11 inches (2) of ore in his last section as follows: (1) Iron, 49.6 per cent; Silica, 12.14 per cent; Phosphorus, 0.578 per cent; and (2) Iron, 50.9 per cent; Silica, 15.05 per cent; Phosphorus, 0.497 per cent. The phosphorus, it will be noted, is comparatively high.

The next section was measured by Ryan in a prospect tunnel on the north bank of a small branch north of the Gaylesville-Fort Payne road. This seems to be the same locality as the first of the above two sections by McCalley and checks closely as to thickness of ore shown (Pl. 10, 15):

Section of iron ore bed 1½ miles northwest of Gaylesville

	Ft.	In.
Shale		
Ore, soft		9
Shale		½
Ore		4
Shale		2½
Ore		4½
Shale		

Dip 15° to 20° SE. Total ore, 1 ft. 5½ in.

In this gap there are evidences of former strip pit mining extending toward the northeast and southwest, and an old tunnel-slope has been driven into shale dipping 25° S. 45° E. on the southwest side of the gap. Water partly filled this slope when visited in November, 1928, submerging the bed of ore that had been mined, but a 7-inch seam of ore was seen near the mouth of the tunnel. Ryan's last section given above probably represents the ore in this tunnel.

The thickest section of ore recorded from this vicinity is the next one which shows a total of 2 feet 2 inches of ore in the lower of two seams and was noted about 1 mile northeast of the Gaylesville-Fort Payne road. (Pl. 10, 16) Unfortunately the ore is parted by several seams of shale:

Section of iron ore beds 2 miles north of Gaylesville

	Ft.	In.
(Upper, or soft seam)		
Shale		
Ore		2½
Shale	10	
(Lower seam)		
Shale		
Ore, soft		3
Shale		7
Ore		2
Shale		3
Ore		8
Shale		½
Ore		10
Shale		3
Ore		3
Shale		

Dip 22° SE. Total ore in lower seam, 2 ft. 2 in.

About 1¼ miles farther northeast, or four-fifths mile southwest of the gap through which the Gaylesville-Broomtown road passes there are remnants of extensive open-cut workings. (Pl. 10, 7) No sections of the ore bed were visible in November, 1928, but many blocks of high-grade, soft ore, some of them 5 inches thick, were noted. The specimens indicated the occurrence of a fine-grained and a coarse-grained ore, presumably in different strata. The soft ore was mined here by stripping uphill toward the northwest and backfilling. There is probably considerable ore still unmined here, under a cover of 15 feet or more. Ryan records this mine as on the Pilgrim land and gives the following section:

Section of iron ore bed 3 miles north of Gaylesville

	Ft.	In.
Shale		
Ore, soft		3
Shale		7
Ore		2½
Shale		5
Ore		9
Shale		2
Ore		7
Shale		

Dip 15° to 20° SE.

Total ore, 1 ft. 9½ in.

In the gap through which the Gaylesville-Broomtown road passes ore has been mined at several places but most extensively on the southeast side of a hollow that heads toward the northeast, where the old open cuts may be followed for more than one-quarter mile. (Pl. 10, 18) In November, 1928, these cuts were so filled with talus as to obscure the lower ore bed, which was the one that has been mined, but a seam 3 to 4 inches thick was exposed in places above the bottom of the cuts. Ryan gives the following section of the ore that was formerly mined here.

Section of iron ore bed 3¾ miles north of Gaylesville

	Ft.	In.
(Lower seam)		
Shale		
Ore, soft		1
Shale		1½
Ore		1
Shale		1
Ore		2
Shale		4
Ore		4
Shale		2
Ore		5
Shale		8
Ore		1
Shale		

Dip 15° to 20° SE. Total ore, 1 ft. 2 in.

[illegible] were examined southwest of [illegible] from Gaylesville to Ring- [illegible] are extensions of the [illegible] overlying the ore [illegible] until a depth of about [illegible] to the high [illegible] thickness of the ores [illegible] measure- [illegible]

Analyses of iron ore from pits respectively 3 and 4 miles north of Gaylesville

Locality	Sample	Basis	Fe	Insol.	Mn.	P	Moisture
Pit 3 miles north of Gaylesville	1	D	52.00	21.00	.10	.08	
		N	49.14	19.85	.09	.08	5.50
	2	D	53.70	18.26	.12	.12	
		N	52.09	17.71	.12	.12	3.00
"	3	D	53.80	17.50	.05	.13	
		N	52.29	17.01	.05	.13	2.80
"	4	D	53.80	17.05	.04	.08	
		N	52.70	16.71	.04	.08	2.00
Two pits 4¼ miles north of Gaylesville	1	D	56.00	16.08	.05	.21	
		N	54.77	15.70	.05	.21	2.20
"	2	D	56.50	14.84	.07	.12	
		N	54.52	14.32	.07	.12	3.50
"	3	D	56.00	13.90	.07	.09	
		N	54.32	13.48	.06	.09	3.00
"	4	D	55.10	16.45	.08	.04	
		N	52.35	15.63	.08	.04	5.00

[1]Basis: D, Dry; N, Natural.

The next sections of the ore bed measured at intervals within the next 2½ miles toward the northeast as far as Mills Creek show its character and its thickness to range from less than 1 foot to 1 foot, 5 inches.

Section of iron ore bed 4½ miles north of Gaylesville

(Pl. 10, 19)

	Ft.	In.
Shale		
Ore, soft		1½
Shale		2½
Ore		1½
Shale		1½
Ore		6
Shale		7½
Ore		4
Shale		2
Ore		4
Sandstone		

Dip 15° to 20° SE. Total ore, 1 ft. 5 in.

Section of iron ore bed 4.8 miles north of Gaylesville

(Pl. 10, 20)

	Ft.	In.
Shale		
Ore, soft		7
Shale		1
Ore		2
Shale		1
Ore		3
Shale		5
Ore		2
Shale		3
Ore		3
Sandstone		

Dip 15° to 20° SE. Total ore, 1 ft. 5 in.

Section of iron ore beds 5¾ miles north-northeast of Gaylesville

(Pl. 10, 21)

	Ft.	In.
(Upper seam)		
Shale		
Ore, soft		7
Shale		2
Ore		4
Shale		
Dip 15° to 20° SE. Total ore, 11 in.		
Shale (to upper seam)	35	
(Lower seam)		
Shale		
Ore, soft		6
Shale		4
Sandstone		
Dip 15° to 20° SE. Total ore, 6 in.		

The next three sections illustrate the variability in the thicknesses of the alternate streaks of ore and shale although the total thickness of ore remains nearly the same.

Section of iron ore beds on Tucker Ridge one-quarter mile southwest of Mills Creek

(Pl. 10, 22)

	Ft.	In.
(Upper seam)		
Shale		
Ore, soft, contains some shale	1	3
Shale		
Dip 15° to 20° SE. Total ore, 1 ft. 3 in.		
(Lower seam)		
Ore, soft		3
Shale		6
Ore		3
Shale		1
Ore		2
Shale		2½
Ore		3
Shale		1
Ore		2
Shale		½
Ore		1
Sandstone		
Dip 15° S. 30° E. Total ore, 1 foot, 2 inches.		

Northeast of Mills Creek the Tucker Ridge or Dirtseller Mountain syncline continues for about 3 miles within Alabama and beyond the State line it extends for about 4 miles into Georgia. The following three sections indicate the nature of the seams of ore on the northwest limb of the syncline.

Sections of iron ore beds in Tucker Ridge, or Dirtseller Mountain, northwest of Panther Creek, ½ mile northeast of Mills Creek (Pl. 10, 24)

	Ft.	In.
(Upper seam)		
Shale		
Ore, soft, in solid bed containing a few kidneys of shale	1	3
Shale		
Dip 15° to 20° S. 20° E.		
Total ore, 1 ft. 3 in.		
(Lower seam)		
Shale		
Ore, soft		3
Shale		2
Ore		2½
Shale		2
Ore		6
Sandstone		
Dip 15° to 20° S. 25° E.		
Total ore, 11½ in.		

Section of iron ore bed in Tucker Ridge, or Dirtseller Mountain, northwest of Panther Creek, ½ mile northeast of Mills Creek

	Ft.	In.
Shale		
Ore		3½
Shale		2½
Ore		2½
Shale		1½
Ore		3½
Shale		1
Ore		6½
Shale		2
Ore		2½
Clay, soft		1
Sandstone		
Total ore, 1 ft. 6½ in.		

Section of iron ore bed on Tucker Ridge one-quarter mile southwest of Mills Creek
(Pl. 10, 22)

	Ft.	In.
Shale		
Ore, firm, but leached, and very rich		3
Shale		6
Ore		7
Shale		3
Ore		3
Shale		1
Ore		0-¾
Shale		1
Ore		1
Shale		4
Sandstone		

Dip 15° S. 30° E. Total ore, 1 ft. 2¾ in.

Section of iron ore bed on Tucker Ridge near Mills Creek

	Ft.	In.
Shale		
Ore, leached, but very dense and heavy		7
Shale		1
Ore		1½
Shale		2
Ore		3¾
Shale		5
Ore		2
Shale		4
Ore		2
Shale		4
Sandstone		

Dip, low, SE. Total ore, 1 ft. 4¼ in.

In the gap of Mills Creek (Pl. 10, 23) McCalley also noted the following section:

Section of iron ore-bearing beds in Gap of Mills Creek in SE¼ of NW¼ of sec. 17, T. 8 S., R. 11 E.
(M. II, p. 805)

	Ft.	In.
Shale		
Ore		0-2
Shale		8
Ore		8
Debris	2-3	
Sandstone, shale	55	
Ferruginous sandstone	8	

Total ore, 10 in.

Section of iron ore bed in Tucker Ridge or Dirtseller Mountain, northwest of Panther Creek, just west of Alabama-Georgia State line (Pl. 10, 25)

	Ft.	In.
Shale		
Ore, soft		9
Sandstone		

(The ore is nearly horizontal)
Total ore, 9 in.

On the southeast limb of Tucker Ridge, or Dirtseller syncline, a little ore has been found in the strip of Red Mountain formation between Mills Creek and the Alabama-Georgia line. From near Mills Creek, southwestward the ore-bearing formation appears to have been cut out by a fault. The following two sections show the character of the ore bed in this locality. At the first place the bed had been mined by the Southern Iron and Steel Company.

Section of iron ore bed in Tucker Ridge or Dirtseller Mountain, southeast of Panther Creek, 1 mile northeast of Mills Creek and about three-quarters mile southwest of the Alabama-Georgia line

(Pl. 10, 26)

	Ft.	In.
Shale		
Ore, soft, good quality	1	3
Sandstone		

Dip 50° NW. Total ore, 1 ft. 3 in.

The next section was measured by Ryan on the bank of Mills Creek which cuts through from the northwest to the southeast side of this ridge, and is apparently the greatest thickness of ore observed in this vicinity. (Pl. 10, 27)

Section of iron ore bed on southeast limb of Tucker Ridge, or Dirtseller Mountain syncline, on southwest bank of Mills Creek, near Dewey.

	Ft.	In.
Shale		
Ore, soft		3
Shale	1	7
Ore	1	10
Sandstone		

Dip 45° NW. Total ore, 2 ft. 1 in.

McCalley noted in the southeast limb of the Dirtseller syncline in the gap made by Mills Creek an outcrop of a seam of siliceous ore about 1 foot, 6 inches thick, and a little southwest of the creek measured the following two sections:

Sections of iron ore bed in NW¼ of NW¼ sec. 29, T. 8 S., R. 11 E.

(M. II, p. 805)

	Ft.	In.
Sandstone	1	6
Ore, ledge		8-9
Ore, ledge		6
Sandstone		

Total ore, about 1 foot 3 inches.

(M. II, p. 806)

	Ft.	In.
Sandstone		8-10
Ore, ledge	1	2
Ore, grading downward into sandstone		6
Sandstone		

Total ore, about 1 foot 8 inches.

At the south side of the gap through which Bagley Branch cuts through the ridge the following section was measured by Ryan (Pl. 10, 18):

Section of iron ore bed on southeast limb of Tucker Ridge, or Dirtseller, syncline, 4½ miles northeast of Gaylesville

	Ft.	In.
Shale		
Ore, soft		3
Shale	1	6
Ore		2
Shale		1
Ore		9
Sandstone		

Dip 48° NW. Total ore, 1 foot, 2 inches.

Southwest of this locality the Red Mountain formation has apparently been faulted below the surface of the southeast limb of the syncline and does not appear again between here and Gaylesville.

In the 2 miles next northeast of the Alabama-Georgia State line the ore bed continues in about the same thickness, sections showing thicknesses of 1 foot 3 inches and 1 foot 4½ inches having been measured on the limb of the Dirtseller syncline southeast of Panther Creek.

In the short ridge on the southeast edge of Gaylesville McCalley noted in several places two seams of ore ranging from 4 to 8 inches in thickness, separated by about 1 foot of shale, but in a partly filled pit saw an exposed thickness of about 1 foot of ore where 2 feet had been reported. The beds here dip very steeply and have ben overturned, as they are involved in the fault which cuts out the Red Mountain formation southwest of here.

Scraper Mountain.—One more area in the vicinity of Gaylesville that is underlain by Red Mountain formation is Scraper Mountain, the northeastward extension of which is known in Georgia as Gaylor Ridge. Of this area McCalley (M. II, p. 807) has written: "Gaylors Ridge within Alabama, is a monoclinal mountain or the more gently sloping northwest side of an unsymmetrical synclinal whose steep and badly crumpled southeast side has been engulfed in the Rome and Cahaba Thrust Fault. It therefore gradually slopes from the elevated crest along its northwest edge south-eastward to the general level of the country. The southeast slope of the Mountain is not much less than the general southeast dip of the strata and so its surface rocks are principally of the uppermost strata of this formation. The steep northwest side of the mountain, with its capping bluff of massive yellowish and red ferruginous sandstones and conglomerates, is also principally of the strata of this formation which are here some 400 feet thick. They, however, do not appear to have any good ore in them, though in their upper part there is a seam of siliceous pebble ore that has doubtless given rise to the loose pieces down on the northwest side of the mountain. On the gentle southeast slope of the mountain, there are some loose nodules of a velvety limonite with sandy seams."

The work of the authors of this report corroborates that of McCalley in regard to Scraper Mountain in that they were unable to locate any iron ore beds of value in the area of Red Mountain formation and therefore have not included any map of that area in this report.

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MURPHREES VALLEY

(Plate 11)

Murphree's Valley is a long, narrow, northeast-southwest trending valley situated mainly in Blount and Etowah counties and in the Gadsden, Springville, and Birmingham quadrangles. At the southwest the valley opens into the Birmingham Valley and at the northeast it terminates in Bristow Cove. The valley is incised in the Sand, or Blount Mountain Plateau along an anticlinal axis, and is surrounded on three sides by the plateau. The anticline is not symmetrical for it is faulted on the southeast limb so that the Cambrian or Ordovician rocks are in contact with the Carboniferous rocks, and for about 20 miles no Silurian rocks appear at the surface along the southeast side of the upper part of this valley. The structure in Murphrees Valley is unusual among the anticlinal valleys of the southern Appalachians in that the strata are dislocated by a fault on the southeast margin instead of on the northwest margin. The Red Mountain formation crops out around the northeast end and along practically the whole of the northwest margin of the valley to its junction with the Birmingham Valley, a distance of about 42 miles. In respect to the distribution of rock formation this valley is just the reverse of Browns Valley described on pages 289-316.

Below Altoona Murphrees Valley is served by the branch of the Louisville and Nashville Railroad that connects Birmingham and Gadsden. Only that part of Murphrees Valley lying northeast of the Birmingham quadrangle and having a length of about 25 miles will be considered in this chapter since the lower part of the valley is more properly a part of the Birmingham District.

The ridge containing the Red Mountain formation on the northwest side of Murphrees Valley is continuous with the so-called "West Red Mountain" of the Birmingham district, but in Murphrees Valley northeast of Oneonta it is called Red Mountain. The nearest point in the Birmingham district where red ore mining has been carried on to any considerable extent is near Compton, about 15 miles southwest of Oneonta. The Compton mine has not been operated since about 1906. At this mine the principal ore bed ranged generally from 2 feet 6 inches to 3 feet thick, but there were local abrupt rolls in the strata which

reduced its thickness to only a few inches. For a mile or so northeast from Compton the red ore seam is reported to show a thickness of 1 foot 6 inches to 3 feet where prospected, and in the part of Murphrees Valley here discussed ore seams ranging from a few inches to more than 3 feet have been measured.

Oneonta.—In the gap through the ridge northwest of Oneonta (Pl. 11 A, 1) three ferruginous seams are exposed in the highway cut. The average dip of the rocks here is about 18° toward the northwest, but the slope of the road is at a smaller angle so that the lowest ore seam, stratigraphically, outcrops at the highest altitude. The three seams outcrop within 125 feet, measured on the road, and within an interval of 25 to 35 feet measured across the strata. The lowest seam is exposed in a short prospect drift on the southwest side of the road near the highest point of the gap in the ridge. It shows a thickness of 1 foot 3 inches to 2 feet 6 inches of dark-colored, soft, granular, ferruginous, argillaceous material with shale above and below. The second, or middle seam, shows 10 inches of hard, granular ferruginous rock underlain and overlain by shale, and detailed sections of the third, or stratigraphically highest, seam which is exposed in an old prospect tunnel cut at the southwest side of the road are as follows:

Sections of the third, or highest, iron ore bed in wagon road cut one-half mile northwest of Oneonta

	Ft.	In.
Sandstone, heavy bed		
Shale	2	1
Limonite concretions	1	8
Hematite, dark, soft, granular, decomposed		6
Shale, hard		
Dip 22° N. 45° W.		
Total ore, about 2 ft., 2 in.		
Sandstone, heavy bed		
Shale with limonite concretions at base	1	11
Limestone, hard, crystalline, ferruginous in places	1	4
Hematite, hard, limy, base not exposed	1	3
Shale and sandstone		
Dip 18° N. 50° W.		
Total ore, about 1 ft. 3 in.		

The limonite apparently has resulted from alteration of hematite in situ. This peculiarity of the bed has been noted in other places along Murphrees Valley and in connection with an ore bed

in Greasy Cove. The Champion brown ore banks are situated on the southeast side of Murphrees Valley about 2 miles from Oneonta and in its broader features the whole deposit suggests a concentration by stream action of residual limonite, clay, sand, and gravel in an ancient channel now completely obscured. The breaking down and hydration of hematite of the bed in the Red Mountain formation along Murphrees Valley may, therefore, have contributed much of the limonite in the Champion ore deposit.

The following analyses of ore from the beds near Oneonta show a soft red ore of medium quality.

Analyses of red iron ore, Murphrees Valley, Ala.[a]

Locality	Fe	SiO_2	Al_2O_3	CaO	Mn	P	H_2O
b—Near Oneonta	42.98	16.30	10.79	.93	.30	.30	6.70
c— Do do	37.03	12.32	7.31	.45	.25	.24	19.30
b— Do do	45.89	15.88	9.06	.56	.32	.30	
c— Do do	42.22	15.74	8.89	.81	.26	.29	8.00
b— Do do	45.90	17.11	9.66	.88	.28	.31	

a—Standard Steel Co., analyst.
b—Dry basis.
c—Wet basis.

Ore was formerly mined from the upper bed in an open cut at the northeast side of the gap in the ridge about 1¼ miles northeast of Oneonta. (Pl. 11, 2) These old workings extended for several hundred feet on the slope of the ridge and were cut back until the cover became too thick to be handled economically. Although the ore bed was nearly everywhere covered by fallen shale, one exposure was found, a section of which is as follows:

Section of upper iron ore bed in gap of ridge 1¼ miles northeast of Oneonta

	Ft.	In.
Shale		
Shale, with streaks of limonite		8
Limonite		5½
Clay		4
Limonite		3
Hematite, dark red, mixed with more or less limonite in shells and concretions		11
Hematite, dark red, soft, granular		10
Shale		

Dip, 21° N. 35° W.
Total ore, 2 ft. 5½ in.

The Geological Survey of Alabama issued in 1893 a descriptive report on Murphrees Valley. The data on red ore in this report are for the most part indefinite, and in certain instances, having been based on reports of interested persons rather than on actual measurements, the thicknesses of the ore beds are probably not dependable. Field examinations have confirmed this surmise in many instances.

Northeastward from the vicinity of Oneonta to Walnut Grove there may be local thickenings of the ore seams but the ore in the thickest beds probably does not average as much as 2 feet thick and the quality is uncertain. Where hard the ore may be a little thicker than where soft, but the hard ore is lean and limy. Gibson reports as many as 5 seams of iron ore, or ferruginous material, in some places within the Red Mountain formation. His notes indicate that the upper seam continues to the northeast of Calvert Prong of Little Warrior River as a concretionary limonitic bed nearly 3 feet in thickness, but no ore could be found at the gap at Calvert Prong at the time of visit in 1928. There is also noted a little lower in the section a locally developed seam of purple-colored ore 1 foot thick containing fossil **Cyathophyllum** and allied corals. This seam resembles the "big coral" seam of greater thickness in Greasy Cove. Evidences of fairly thick ore are cited by Gibson in secs. 1 and 2, T. 12 S., R. 2 E., 7 to 8 miles northeast of Oneonta, or about 5 miles southwest of Walnut Grove. Here the upper seam had been prospected in several places, showing thicknesses of 2 feet to 3 feet and averaging 2 feet 6 inches. The material is reported to be wholly concretionary (probably limonite) of rather low grade but uniform in character. In the present survey the outcrop of Red Mountain formation was examined at many places between Oneonta and Walnut Grove without finding promising showings of iron ore, and well informed residents of Walnut Grove and the country toward the southwest stated that there is no commercial ore in the vicinity.

Walnut Grove.—The following three sections of red iron ore beds near Walnut Grove as shown by test-pits and recorded in field notes of the Birmingham Mineral Railroad (Louisville and Nashville System) are given by McCalley:

Section of iron ore bed near the summit of Red Mountain in the NE¼ NE¼ sec. 22, T. 11 S., R. 3 E.

(M. II, p. 203)

	Ft.	In.
Sandstone, roof		
Red ore, inferior		11
Clay		5
Red ore, inferior	1	5
Clay floor		

Total ore (inferior), 2 ft. 4 in.

Section of iron ore bed on Red Mountain 400 feet north of the Guntersville Road, in the NW¼ SE¼ sec. 14, T. 11 S., R. 3 E.

(M. II, p. 203)

	Ft.	In.
Drift, roof		
Red ore, soft and inferior		8
Clay	1	5
Red ore, inferior	2	3
Clay		2
Red ore, inferior		8
Slate floor		

Total ore (inferior), 3 ft. 7 in.

Section of iron ore bed on the southeast side of Red Mountain, in the NE¼ NE¼ sec. 14, T. 11, R. 3 E.

Slate, arenaceous, roof		
Red ore, soft		5
Limestone		2
Red ore, soft		9
Clay, yellow, floor		

Total ore, 1 ft. 2 in.

In the gap northwest of Walnut Grove no signs of red iron ore were seen. Gibson[1] indicates that the Red Mountain formation has been folded or faulted downward and does not appear in this gap. In the first gap northeast of Walnut Grove about 25 feet below the crest of the ridge there was noted a small block

[1]Gibson, A. M., Op. cit., p. 45.

of red ore less than 1 foot thick, evidently not in place. The material was granular, sandy and of mediocre grade.

On the northwest slope of the ridge northwest of Walnut Grove (Pl. 11, 3, 4, 5) manganese ore has been found in quantities large enough to encourage mining it on a small scale from time to time when prices were high. These deposits were visited in October, 1916, when mining was active, again in November, 1928, a few months after mining temporarily had been discontinued, in October, 1930, and in 1936, when again there was a little activity.

The manganiferous material is in the area of the Fort Payne chert, stratigraphically higher than the iron ore in Red Mountain, but since the general northwest dip of the beds in Red Mountain is a little greater than the slope of the ridge, the rock below the manganiferous deposits is entirely concealed by debris of chert and sandstone from the ridge to the southeast. The deposits begin 50 or more feet above the local stream level and are 150 to 200 feet below the Blount Mountain plateau. They seem not to be related to any definite plain.

The principal deposits of the manganese ore are lens-shaped and occur in clay overlain by disintegrated chert and debris of sandstone, but deposits higher on the slope of the ridge are associated with beds of chert in place. The ore is found at depths from a few feet to as much as 40 feet and is mined from trenches and from wells or shafts from which underground drifts are driven following "leads" or pockets of ore. The drifts are rarely timbered and are allowed to collapse after the ore is mined out. The ore in the lower zone, which has furnished the bulk of the output, consists largely of soft, black powdery pyrolusite and wad. Psilomelane is also present in mammilary lumps and as a cement between fragments of chert. In places it has partly replaced chert along the outcrop and lumps of this mineral and of manganite are occasionally found in the pyrolusite. The deposits vary greatly in richness and within the manganiferous zone there is much barren ground. The manganiferous zone in this vicinity is about 400 feet wide across the strike of the rocks. Two tracts about 2 miles apart were being worked in 1930. In mining the principal impurities are picked by hand from boxes of ore, but some mechanical system for removal of the large proportion of waste is needed. Some attempts to wash the ore evidently had been made prior to

1928. A truck haul of about 5 miles over hard surfaced roads to the Louisville and Nashville Railroad at Altoona is involved. Analyses reported of shipments from 1916 to 1930 showed the ore to range from 26 to 52 per cent in manganese, 1 to 7 per cent iron, 15 to 20 per cent silica, 0.2 to 0.8 per cent phosphorus, and water as much as 25 per cent.

A reddish brown-to chocolate-colored soil affords an indication of the presence of manganese ore, and according to local reports this ore has been found and prospected at several other places in the same belt of Fort Payne chert. There is probably a fair-sized reserve of ore here—perhaps three or four times as much as has already been mined. Gibson[1] records knowledge of these deposits prior to 1893 and mentions occurrences over a range of more than 25 miles along the strike-outcrop.

In the gap cut by Locust Fork of Warrior River in the ridge about 1½ miles north-northeast of Walnut Grove a 4-foot bed of iron ore has been reported, but it was not possible to find as great a thickness. The following section was measured on the hillside at the southwest side of the gap about 40 feet above the level of the wagon road. (Pl. 11, B, 6)

Section of ferruginous beds on SW. side of Locust Fork, Warrior River, (probably NE¼ sec. 14, T. 11 S., R. 3 E.)

	Ft.	In.
Sandstone in beds 8 in. to 12 in. thick		
Shale		3
Calcareous ferruginous sandstone ("jack rock")		3½
Shale, with some good streaks of ore	1	3
Shale		½
Ore, limy, fine grained		3-4
Shale		1-2
Ore, limy, hard, fossiliferous	1	1
Shale		
Dip 15° N. 50° W.		
Total ore, about 1 ft. 10 in.		

The strata in the cut vary in thickness but the aggregate thickness of the ore becomes no thicker, so far as exposed, and evidently would not pay to mine underground.

[1]Gibson, A. M., Op. cit., p. 45 and pp. 110-119.

Another prospect noted 50 feet higher on the same hillside in a tunnel about 15 feet long showed the following section:

Section of ferruginous beds on SW side of Locust Fork, Warrior River about 1.5 mile north of Walnut Grove

	Ft.	In.
Sandstone, massive		
Sandstone, soft, shaly, ochreous	1	11
Dark, hard, siliceous rock, somewhat ferruginous		7
Dark, hard, argillaceous, ferruginous rock, becoming limy toward the base. The bed is broken and nodular as though of reworked material. Contains fossil corals	3	
Clay		
Dip 15° to 18° N. 50° W.		

The ferruginous material is not an ore.

In 1941 a record was made of the ferruginous bed exposed on the northeast side of the main road through Bristow Cove about 1.6 miles north-northwest of Walnut Grove:

Section of ferruginous beds on Bristow Cove road 1.6 miles north-northeast of Walnut Grove

	Ft.	In.
Shale		
Iron ore, argillaceous		3to 4
Shale		9
Iron ore, argillaceous		6 to 7
Shale		1
Clay, ferruginous		6
Shale		
Dip 16° N. 15° W. Total ore about 1 foot, 1 inch.		

Aurora.—In the gap through the ridge containing the Red Mountain formation about one-half mile north of Aurora some prospect trenches were dug in search of ore about 1885. It was reported that three seams of ore were opened, but the only seam that could be found showed the following sction:

Section of iron ore bed in gap north of Aurora

	In.
Calcareous sandstone ("jack rock")	
Ore, soft, rich, fossiliferous	6
Shale	
Dip 20°± N. 50° W. Total ore, 6 in.	

With regard to the ore-bearing formation in the upper end of Murphrees Valley northeast of Aurora McCalley mentions a hard limy seam reported to him as about 4 feet thick and another series of thin seams alternating with shale partings, the ore ranging from a fraction of an inch to 2 feet thick. One and one-half miles northeast of Aurora the outcrop of the Red Mountain formation bends around the northeast end of the cove and turns back to the southwest so that the plan of its outcrop is hook shaped, and terminates in a fault. Near the southwest end of the outcrop McCalley made the following two sections (Pl. 11, 8):

Section of iron ore seam in old test pit No. 1 in SE¼ SW¼ sec. 36, T. 10, R. 4 E.

(M. II, p. 205)

	In.
(7) Shale, debris	
(6) Red ore, soft and good	2-3
(5) Shale	2-3
(4) Red ore, soft and good	3-4
(3) Shale	3
(2) Red ore, soft and good, about	6
(1) Shale, visible to a depth of	4-5

Total ore, about 1 foot

Section of iron ore seam in old test pit No. 2 in the SE¼ SW¼ sec. 36, T. 10, R. 4 E.

(M. II, p. 205)

	Ft.	In.
(8) Shale, yellow, visible	4	
(7) Red ore, soft and good	1	6
(6) Shale		1-2
(5) Red ore, soft and good		2
(4) Shale		1-2
(3) Red ore, soft and good, about		6
(2) Red ore, shale, the ore is shaly		4
(1) Shale, visible to a depth of	4	

Total ore, about 2 ft. 6 in.

The first of these sections was evidently close to the fault line since the strata were badly broken and showed varying dips.

As heretofore stated, the Red Mountain formation is cut out along most of the southeast side of the upper part of Murphree's

Valley by a fault and the only place where it outcrops on this side of the valley above Oneonta is in a short strip near the Champion brown ore mine. At this place part of the formation is buried by the fault and the few feet that are exposed here have not been observed to carry any ore.

Resume of iron ore reserves in Murphrees Valley

The approximate length of outcrop of iron ore beds 2 feet or more in thickness north of Oneonta in Murphrees Valley is about 1.75 miles, or 9240 feet. The average width down the dip of workable ore is placed at 1,000 feet, although it might be more than this distance. The average thickness of the ore bed appears to be 2.6 feet. The estimated total quantity of recoverable soft, semihard, and hard ore appears to be approximately 1,702,000 long tons.

SPRINGVILLE AREA

(Plate 12)

Between Springville and Whitney the Red Mountain formation crops out in a well-marked ridge along the southeast base of Blount Mountain. This area lies within St. Clair County in the Springville quadrangle. The iron ore-bearing ridge lies ½ to 1½ miles northwest of the Birmingham-Chattanooga highway.

Springville to Whitney.—The strip of Red Mountain formation northwest of the Alabama Great Southern Railroad represents the outcrop on the southeast limb of the Blount-Chandler Mountain syncline; it extends northeastward about 25 miles where it bends around the northeast end of Chandler Mountain into Greasy Cove.

In the gap through which a local road passes, about 2 miles north-northwest of Springville, an ore bed was opened and some soft ore obtained from trenches on the outcrop, which extended northeastward several hundred feet on the strike of the beds and to the top of the ridge 120 feet or more above the road (Pl. 12, 1). Two beds of ore, about 75 feet apart, crop out in the road. About 150 tons of ore are reported to have been shipped from here to furnaces at South Pittsburg, Tenn., about 1887-88.

Section of iron ore bed in prospect 2 miles northwest of Springville

	Ft.	In.
Shale		
Ore, medium grade	3	
Ore, lean, siliceous	1	6
Sandstone		
Dip about 15° N. 25° W.		
Total ore	4	6

In the next 4 miles to the northeast on the ridge or series of knobs that represent the ridge south of Big Canoe Creek there has been a little prospecting and surface mining, the workable part of the bed ranging from 2½ to 3 feet thick. The dip is not everywhere entirely regular. Where it is 20° or less the beds usually crop out on both the southeast and northwest sides of the ridge. The strata seem to be folded into gentle rolls whose axes are

parallel with the crest of the ridge, and in places the dip becomes abruptly steeper or even overturned.

About 2¼ miles east-northeast of Springville the ridge is crossed by a local road that turns toward the north from the highway and in this road several thin seams of ore crop out within about 50 feet of the Red Mountain formation (Pl. 12, 2). These ore seams range from a few inches to 2 feet in thickness. The beds are nearly vertical and strike N. 52°-60° E. The 2 foot seam of ore is near the top of the ore-bearing section, and is well-leached, fine-grained, siliceous hematite with a few knots of shaly material. This bed has been mined along a trench which extends almost continuously for nearly one fourth mile southwest of the road. When visited in 1939 no recent work had been done and caving along the trenches had covered the ore bed.

Section of iron ore beds along local road about 2¼ miles east-northeast of Springville

	Ft.	In.
Shale and interbedded sandstone		
Ore, firm, fossiliferous, occasional clay lenses		2
Shale parting		1
Ore, firm, fossiliferous, with clay knots	2	
Shale and interbedded sandstone	10	
Ore, fine-grained		3
Shale and interbedded sandstone	12	
Ore, crumbly, argillaceous, somewhat altered to limonite		8
Shale		3½
Ore, argillaceous		6
Shale with interbedded sandstone ... about	25	
Ore, sandy		6½
Ore, crumbly, argillaceous	1	4
Shale with interbedded sandstone		
Dip about 60° N. 25° W.		
Total ore in about 50 feet of strata	5	5½

St. Clair Switch.—About 1 mile north of St. Clair Switch mining was carried on for about two years in the later eighties. (Pl. 12, 3) The outcrop on the southeast side of the ridge was mined from open cuts until the cover reached a thickness of 15 to 20 feet, and then underground drifts and shallow slopes were driven, ranging from 50 to 200 feet long. The ore is overlain first by a thin bed of ferruginous, pebbly sandstone, which grades

into yellowish shale above. The rocks of the Red Mountain formation here, particularly the upper shale, more nearly resemble the beds in the formation farther northeast in the valleys of Lookout and Chickamauga creeks than those near Birmingham. A surface section measured at these workings showed a bed 4 feet 6 inches thick, the top 21 inches of which were gray, ferruginous, crystalline limestone with silica pebbles scattered through it, while the lower 33 inches were composed of very soft, dark, decomposed ore, rather coarse-grained. The beds dip 18° N. 70° W. where this section was measured.

Section of iron ore bed in open cut 1 mile north of St. Clair Switch

	Ft.	In.
Shale		
Sandstone, coarse		3
Sandstone, pebbly, ferruginous		6
Limestone, crystalline, ferruginous, with silica pebbles, weathers to soft iron ore	1	9
Ore, soft, coarse grained, dark	2	9
Sandstone, brown		
Dip 18° N. 70° W.		
Total ore	4	6

The ore as mined ranged from 3 feet to 4 feet thick; 12,000 to 15,000 tons of soft ore are reported to have been shipped from here. Analyses of these soft ores made by the Geological Survey of Alabama show a range in iron of 48 to 50 per cent with about 20 per cent of silica. (Analyses No. 1 and 2, p. 271.) This district was visited in August, 1939. It was reported locally that two carloads of ore had been mined here in 1938, but that a larger quantity of ore had been shipped from these workings in 1919, when most of the openings were made.

Most of the old trenches, tunnels, and drifts were made on an ore bed which crops out about half way up the southeast side of the ridge. About 1½ miles north-northeast of St. Clair Switch, a second group of old workings is found along an ore bed which crops out near the crest of the ridge on the southeast side. Two ore beds are thus indicated, but the attitudes of the rocks to the northeast and southwest suggest that the two outcrops may be on he same bed, duplicated by faulting. The ore beds at the two outcrops have low dips to the northwest but within the next 300 feet to the northeast a new prospect shows the lower bed to have a dip of 45° N. 50° W.

Sections on iron ore beds 1½ miles north-northeast of St. Clair Switch,
Section in short drift on lower bed

	Ft.	In.
Shale		
Ore, soft, with shale lenses		8
Shale parting		1
Ore, firm, dense, fossiliferous	1	6

Dip 10°-12° N. 45° W. Total ore 2 feet, 2 inches.

Section in small valley, 50 feet southwest of above drift

	Ft.	In.
Shale		
Ore, soft, oolitic, fossiliferous		4
Shale parting		1
Ore, hard, limy, fossiliferous	2	

Dip 10°-12° N. 45° W. Total ore 2 feet, 4 inches.

Section near southeast crest of ridge, at head of small valley

	Ft.	In.
Shale with Pentamerus oblongus (?)		8
Shale	6	
Ore, firm, fossiliferous, soft	2	4

Dip 10° N. 60° W. Total ore 2 feet, 4 inches.

Caldwell.—Northeast of St. Clair Switch locally the ore bed thins and becomes very lean. At Goodwins Mill, northwest of Caldwell Station, a bed of ferruginous sandstone, or very lean soft ore, about 2 feet thick occurs in the road northeast of the mill about 130 feet stratigraphically below the black Chattanooga shale. (Pl. 12, 4) The strata are overturned here and dip about 40° S. 65° E.

On the northeast side of the road a new prospect showed in 1939 a bed of fossiliferous hematite from 1 foot, 4 inches to 1 foot, 6 inches thick, with a thin shale parting in the middle of the bed. The ore contained many clay and shale lenses. The strata are overturned here and dip 60° S. 60° E.

On the northeast side of Big Canoe Creek just above the dam back of Goodwins Mill the following section was measured in 1928. Two or three ferruginous seams are reported to be present in this locality, but probably this is the thickest.

Section of ferruginous beds at Goodwins Mill

	Ft.	In.
Sandstone, ferruginous	1	1
Shale		2
Ore, soft, generally good, some shale spots	1	4
Sandstone, shaly, ferruginous		6
Sandstone, ferruginous		7
Sandstone	2	

Dip 53° S. 65° E. . Total ore, 1 ft. 4 in.

Beginning about 1 mile northeast of Goodwins Mill the ore bed is locally thicker and of better quality and mining has been carried on by stripping and trenching for almost 1½ miles (Plate 12, 5). All of the ore mined in this vicinity apparently has been taken from one bed whose outcrop has been duplicated by the erosion of a series of rolls parallelling the strike of the beds. Trenches and strip pits have been made along an outcrop near the crest of the ridge on the northeast side and follow the ore down the dip along the sides of small valleys opening to the northwest whose bottoms, in part, have been cut below the ore bed. Other trenches have been cut parallel to the strike where local rolls brought the ore to the surface. In two places near the northeast end of this area the ore has been mined from small synclines on the crest of the ridge. About 1900 a tunnel was driven into the south side of the ridge under one of the synclines but did not encounter the ore. Later another tunnel was driven almost through the ridge from the northwest side about 600 feet northeast of the first tunnel and also missed the ore. The ore in this area was worked about 1917, and in 1936-1938. In 1928 shale had slumped over the ore in most places, but measurements of the bed at four places showed thicknesses respectively of 1 foot, 6 inches; 2 feet, 1 inch; 3 feet, 3 inches; and 4 feet. In 1939 measurements on the bed exposed by the later mining operations showed the range in thickness to be from 1 foot, 2 inches to 2 feet, 1 inch in the well-exposed places. These thicknesses seem to be typical for the area, and the greater thicknesses are thought to be local increases due to folding.

The ore is soft, fossiliferous, rather dark-colored, somewhat siliceous, but of good specific gravity. The bed is stratified, considerably slickensided and jointed; a quantity of fragmentary ore shows on the crest of the ridge. Sections are as follows:

Section of iron ore bed about 2 miles northeast of Goodwins Mill

	Ft.	In.
Shale		
Ore, soft, oolitic, fossiliferous		10
Clay mixed with ore		3
Ore, firm, fossiliferous	1	

Dip 43° N. 50° W. Total ore about 2 feet, 1 inch.

Section of iron ore bed about 2 miles northwest of Goodwins Mill

	Ft.	In.
Shale, sandy		
Ore, soft, much jointed, contains some shale concretions and a seam possibly one-half inch thick of shale near the middle	2	1
Sandstone		

Dip 52° N. 55° W. Total ore, 2 feet, 1 inch.

It is reported that 75 to 100 carloads of this ore were sent to the blast furnace at Gadsden in 1911. A partial analysis of the ore, which carried 45.75 per cent metallic iron, is given on page 271, No. 3. Several other carloads of ore are reported to have contained 47 to 50 per cent metallic iron.

Whitney.—For several miles northeast of the open cuts northeast of Goodwins Mill there is little evidence of the ore bed, and it is possible that it has been buried by a fault which has brought the Red Mountain formation in contact with Cambrian or Ordovician rocks on the southeast. The ore bed thins toward the northeast in all probability, for at Beesons Mill on Gin Creek (Plate 12, 6) it is, according to McCalley, 1 foot 6 inches to 1 foot 8 inches thick. Between 1880 and 1890 some prospect drifts were made there but these, which were partly obscured at the time of McCalley's visit have since been entirely obliterated. The rocks show the effects of much disturbance in this locality, both the dip and strike varying greatly within a few rods. The following section, measured by McCalley at the mouth of one of the drifts, gives a fair representation of the ore seam and its inclosing rocks:

Section of iron ore bed on northeast side of Gin Creek near center of the NW¼ sec. 26, T. 13 S., R. 3 E.

(M. II, p. 278)

	Ft.	In.
Shale, dark		
Shale, ochreous, may contain a little ore		4
Ore	1	6
Shale, visible	6-8	
Total ore	1	6

The following analyses are mostly of soft ores from the strip of Red Mountain formation along the northwest side of Big Canoe Creek Valley:

Analyses of red iron ore near Springville and Caldwell

Locality	Authority-a	Fe	SiO_2	Al_2O_3	Insol.	CaO	Mn	P
Drift, 4¾ miles northeast of Springville, NW¼ NE¼ sec. 27, T. 14, R. 2 E.	M-II. 227	50.02	19.75					0.168
Outcrop, 5 miles northeast of Springville, NW¼ NE¼ sec. 27, T. 14, R. 2 E.	Ditto	48.31	20.55					0.120
2 miles north of Caldwell Station	S	45.75			22.94		.40	0.28
Caldwell	S	51.52	9.72	5.55		.84	.35	0.15

a—M-II, McCalley, Henry, Report on the valley regions of Alabama, Pt. II, 1897, pages as numbered. S, Standard Steel Co.

South and East of Springville.—A hook-shaped strip of Red Mountain formation lies on the northwest and northeast border of a sharply folded synclinal basin of Carboniferous rocks at the northern end of the Cahaba coal field south of Springville. (Plate 12) Each end of the strip of Red Mountain rocks is cut off by faults and the strata generally dip steeply toward the basin or else have been overturned so as to reverse the dip. This latter condition seems to be due to a fault at the northern extremity of the hook.

The outcrop of the Red Mountain formation south of Springville is obscure and shows no ore, as the ore beds are probably faulted completely out for a distance of 9 or 10 miles southwest of

the town. The road to Odenville crosses the outcrop of the Red Mountain formation at the south edge of Springville. The rocks consist of sandstone and shale that dip 57° N. 50° W. No iron ore shows at this place, and part of the formation here is probably involved in the fault.

St. Clair Springs.—There is a thin seam of iron ore in the strip of Red Mountain formation south of St. Clair Springs, or east of Springville, but it is of doubtful commercial value. McCalley (II, p. 286) reports a seam of "very fine" ore 6 inches to 8 inches thick in a short spur on the north side of the mountain in the SW¼ SW¼ sec. 33, T. 14 S., R. 2 E., or about 2 miles east of Springville. (Pl. 12, 7). This locality does not, however, correspond closely with the outcrop of the Red Mountain formation on the geologic map of Alabama, where it is shown in all quarters of section 33 except the southwest quarter. In the gap southwest of St. Clair Springs a bed of ore about 1 foot 3 inches thick overlain by heavy cover was observed in some prospect cuts. (Pl. 12, 8).

The following analyses of soft ore from the vicinity of St. Clair Springs are reported to have been made by the Standard Steel Co.

Analyses of red iron ore from near St. Clair Springs

Locality	Fe	SiO_2	Al_2O_3	CaO	Mn	P	H_2O
St. Clair Springs	46.32	21.48	6.28	.88	.31	.17	12.2
Do	48.60	21.12	5.67	.59	.25	.17	10.8

On the crest of the ridge northeast of a point on the Odenville road 3.2 miles southeast of Springville (pl. 12, 8) eight or more small prospect pits were noted in 1939. The ore is slightly oolitic and fossiliferous with clay lenses and small clay pebbles. It grades upward into shaly ore with small rodlike fossil spicules. At the top the ore scales off into thin peices. The total thickness of the ore bed appears to average not more than 1 foot. The bed dips 20° S. 30° W. It was reported at Springville that one carload or more of ore had been shipped from these prospects within the preceding six months and that it contained 52% to 55% iron, about 0.32% phosphorus, and a high percent of insolubles.

Five and one-half miles southeast of Springville, the outcrop of the Red Mountain formation has been bent around by the fold in the strata and finally terminates in a fault that has a northeast strike. Some prospecting has disclosed a bed of ore cropping out near the top of the hill about 115 feet above the level of the Odenville-Springville road which passes through a gap in the ridge here. The actual thickness of the bed could not be measured but at the outcrop prospect a block of ore 1 foot 6 inches thick was noted. The ore is of fair grade, coarsely siliceous and leached of its lime in places. Much ore debris is scattered over the surface and shows slickensides and fractures. Two prospect tunnels reported to have been driven in 1922 extend into the hillsides in a direction N. 55° W., across beds of sandstone dipping 60° S. 75° E. These tunnels are respectively 60 feet and 90 feet above the road. Water prevented examination of the ore in tunnels when visited in 1928 but there is much ore on the dumps, some blocks being 1 foot 2 inches thick.

At this locality (Pl. 12, 9), which is near the Cahaba fault, a prospect hole was locally reported to have been bored in 1925 to an oblique (45°) depth of 1,252 feet. According to the record two beds of iron ore, separated by sandstone, were encountered at respectively 386 feet and 684 feet from the surface. The reported thicknesses of the ore beds were 7 feet for the upper and 9 feet for the lower. After correction for assumed dip of 60° and the angle of the hole, 45°, the true thicknesses would be a little smaller. The lower bed was reported to be mixed with shale. It is doubtful if the actual thickness of the upper hole is greater than 5 feet.

An analysis of ore from this drill hole is reported to have shown 41.9 percent metallic iron, 20.5 percent insoluble, 7.5 percent calcium carbonate, and 0.36 percent phosphorous. Certain analyses of the ore from prospect pits on the outcrop from the southwest quarter of section 26 to the northeast quarter of section 23 showed about 48 percent iron, and 21 percent insoluble.

McCalley (II, pp. 286-287) reports the outcrops of Red Mountain formation discontinuously extending for about 2 miles in this locality along the fault zone from the SW¼ NE¼ sec. 23 to the NW¼ sec. 34, T. 15 S., R. 2 E., and cut off at each end by faults. A bed of ferruginous rock, well leached to the condition of soft iron ore, has been observed in the NW¼ SE¼ sec. 23 and in the

NW¼ SW¼ sec. 26, T. 15 S., R. 2 E., having a reported thickness of 4 to 5 feet. The rocks have suffered considerable disturbance here and are overturned so that the dips are between 15° and 40° to the east-southeast. Analyses of average samples from these two localities dried at 110°, are as follows:

Analyses of red iron ore from southeast of Springville
(M. II, p. 287)

Locality	Fe	SiO_2	P
NW¼ SE¼ sec. 23, T. 15, R. 2 E.	33.49	26.47	.200
NW¼ SW¼ sec. 26, T. 15, R. 2 E.	49.29	20.01	.069

Cedar (Barker) Mountain.—A strip of Red Mountain formation less than 2 miles long occurs along the top and the southeast slope of Cedar, or Barker, Mountain, (Plate 12) beginning about 2½ miles east of St. Clair Springs. The formation dips southeast and is overlain by the Chattanooga shale, above which is the Fort Payne chert faulted against shale of Cambrian age. A few prospect pits have been dug on the southeast slope of this mountain which show only a fractured reddish argillaceous rock, not an iron ore, and if any ore is present it could have only a small areal extent on account of the fault which cuts it off on the southeast, as shown on the geologic map of Alabama. The mountain has been well traversed on foot and no debris of red ore was found.

Resume of iron ore reserves in the Springville area

The approximate length of outcrop of iron ore beds 2 feet or more thick in the Springville area between Springville and Whitney is 8 miles, or 42,240 feet. The average width of workable ore down the dip is placed at 1,000 feet, if not reduced by undetermined faults. The average thickness of the ore bed appears to be about 2.85 feet. The estimated quantity of recoverable soft, semihard, and hard ore appears to be approximately 8,527,000 long tons, which is greater than that of either the Greasy Cove or Shinbone Ridge areas, a not wholly consistent conclusion.

COOSA VALLEY RIDGES

(Plates 13 and 14)

Much of the iron ore region of northeastern Alabama is drained by the Coosa River, in fact, much more than will be grouped under the head of Coosa Valley Ridges. For instance, Wills Creek, Little Wills Creek, Big Canoe Creek, and Little River, all of which drain areas described under other geographic divisions, are all tributary to the Coosa, but in the present instance only such areas as are nearer the valley of the river will be included, such as Cedar Mountain, Canoe Creek Mountain, Dunaway-Elliott Mountain, Greens Creek Mountain, Beaver Creek Mountain, and Colvin Mountain.

Canoe Creek Mountain

(Plate 13A)

In strike with, and beginning about 6 miles northeast of Cedar Mountain, Canoe Creek Mountain extends northeastward about 6 miles. Farther northeast is a ridge known as Dunaway Mountain near Big Canoe Creek, and as Elliott Mountain near Coosa River. The Red Mountain formation crops out just southeast of Ashville and extends practically the length of Canoe Creek Mountain. Near the extremities of the strip the formation is faulted against the Cambrian rocks, but the intermediate area is overlain normally by the Chattanooga shale and the Fort Payne chert, the latter bordered on the southeast by the fault. The northeastward continuity of Canoe Creek Mountain is interrupted for a mile or more by an area of lower land and the axis is offset slightly to the southeast. These topographic features appear to be closely related to the rock structure. About 6 miles northeast of Ashville the Red Mountain formation is faulted out for a distance of about 4½ miles to a point three-fourths of a mile beyond the gap made by Big Canoe Creek and then extends northeastward along the southeast slope of Dunaway and Elliott Mountains for a distance of about 7 miles.

Ashville.--Near Ashville there is evidence of the presence of one or more seams of red iron ore on Canoe Creek Mountain. On the southeast slope there is much debris in large slabs of good soft ore 10 inches to 12 inches thick, and on the northwest slope near

the crest of the ridge a highly ferruginous conglomerate crops out in places. Some prospecting has been done in this area. At a point 1½ miles northeast of Ashville about seven-eighths of the distance to the top of the southeast slope of the mountain, (Pl. 13A, 1) the top 7 to 10 inches of a bed of soft ore was exposed. The bed dips 32° S. 60° E., in places a little steeper than the slope of the ridge. The ore has been exposed in three other prospcts and in several gullies on the slope in this vicinity, but shows mainly as loose, massive slabs generally 8 to 10 inches thick. The ore is finely granular, contains some silica grains visible under a field lens, a little argillaceous material, and many of the hematite granules have been altered to limonite. There is much debris of this ore bed on the southeast slope of the ridge due to the ore lying close to the surface and for this reason considerable of the bed may have been removed by erosion.

In 1939 several prospects were examined on the southeast side of the crest of the ridge about 2 miles northeast of Ashville. Two seams of ore, separated by 10 to 12 inches of shale, were seen. The lower bed is fossiliferous and oolitic with scattered sandy streaks, clay pebbles, and clay lenses. The upper bed is similar but contains an abundance of fine sand grains. Analyses of picked samples were reported locally to show from 48 to 56% metallic iron, but no analyses were available of ore shipped from this locality. Two sections measured in this area are as follows:

Sections of iron ore bed on ridge about 2 miles northeast of Ashville NW¼ NW¼ sec. 3, T. 14 S., R. 4 E.

	Ft.	In.
Shale		
Ore, sandy		6
Shale and sandstone	1	
Clay, ferruginous		2
Shale and clay		2½
Ore		11½

Dip 20° S. 20° W. Total ore 1 foot, 5½ inches.

Section of iron ore bed in SW¼ SW¼ sec. 34, T. 13 S., R. 4 E.

	Ft.	In.
Shale		
Ore, sandy		7½
Shale		10
Ore, sandy, granular		2
Clay, ferruginous		3
Ore		8½

Dip 25° S. 30° W. Total ore 1 foot, 6 inches.

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Four and three-fourths miles northeast of Ashville near the crest of the ridge the following section was made by McCalley (Pl. 13A, 2):

Section of iron ore bed 4½ miles northeast of Ashville, in the SE¼ sec. 26, T. 13 S., R. 4 E.
(M. II, p. 289)

	Ft.	In.
(5) Ore, sandy, very poor, in ledge from	1 to 2	6 to 0
(4) Shale and ore, in irregular alternate seams, some of ore is good quality but mostly very sandy; visible about	1	6
(3) Debris, about	4	0
(2) Conglomerate and sandstone, ferruginous		
(1) Debris		

In this vicinity Canoe Creek Mountain consists of two parallel ridges with a broad cove between. In the northwest, or higher ridge, about half way up the southeast slope a sandy, ferruginous bed was noted, 3 feet 8 inches or more thick, dipping 23° S. 50° E. The upper one-third of this seam, where leached, might be styled a siliceous ore, but the material grows leaner downward and at the base is merely a ferruginous sandstone.

Five and three-fourths miles northeast of Ashville this same sandy seam has been prospected on both sides of a small hollow in the southeast slope of the mountain. In the west prospect the bed showed the following section (Pl. 13A, 3):

Section of sandy iron ore bed 5¾ miles northeast of Ashville

	Ft.	In.
Shale		
Ore, leached, fairly good quality		8
Ore, sandy	2	10
Shale, knife-edge parting		
Ore, sandy		7
Sandstone, ferruginous		7

Total ore, mostly sandy, 4 feet 1 inch.
Dip 20° S. 20° E.

This material is finely granular and contains, besides a large percentage of silica, some argillaceous matter in small concretions. The top 7 to 8 inches, or the best portion, is very much darker

than the usual shade of red ore and the middle portion is also comparatively dark. Samples of both layers give a red streak and are of medium specific gravity, but neither is rich in iron.

Northeast of the latter locality there are at and near the crest of the ridge several "spreads" of ore debris in blocks and slabs. The ore consists of two varieties, a granular, fossil ore and a more highly siliceous type which apparently is the lower bench of the bed. Slabs of the fossil ore reached 10 inches and the siliceous ore 1 foot, 2 inches in thickness. There is also in the Red Mountain formation here a coarse, gritty, somewhat ferruginous sandstone.

South of Localities 2 and 3, Plate 13A, southeast of Canoe Creek Mountain a ridge, not shown on the topographic map of the Springville quadrangle, lies just north of the wagon road, and on the south slope of this ridge, which is entirely distinct from Canoe Creek Mountain there is much iron ore debris. The field relations suggest that the outcrop of the Red Mountain formation, which normally has passed below Chattanooga shale and Fort Payne chert on the southeast slope of Canoe Creek Mountain, has been repeated by a small fault, parallel and close to the great fault.

Dunaway-Elliott Mountain

(Plate 13, B)

Canoe Creek Mountain terminates about 4 miles southwest of the gap of Big Canoe Creek but it is succeeded toward the northeast by another ridge, the axis of which has about the same northeast strike. This second ridge is about 10 miles long and is broken only near the southwest end where it is cut in two by Big Canoe Creek. On the northeast side of the creek this ridge is known as Dunaway Mountain, but 5 or 6 miles farther northeast the ridge is called Elliott Mountain. Although the portion of this ridge southwest of Big Canoe Creek contains a short strip of Red Mountain formation, the only material resembling red ore that is present is a ferruginous bed containing pebbles of shale and of quartz but not rich enough for an ore. The ore bed that is present southwest of Big Canoe Creek may have been faulted out of the section here.

Dunaway Mountain.--On the southeast slope of Dunaway Mountain about half a mile northeast of the gap made by Big Canoe Creek there is a large "spread" of red ore dipping about 10° S. 65° E. (Pl. 13B, 4) It caps the highest part of the ridge but is eroded by a deep hollow and reappears again on the southeast side of the hollow where the broadest outcrop occurs. The thickness of this ore is 1 foot to 13 inches. The top few inches are of granular fossiliferous ore but the bed grades below into sandy ferruginous material, and as a whole the deposit does not appear to be of commercial grade. Northeast of here at two places where roads cross the mountain respectively 4½ and 5½ miles northeast of Big Canoe Creek the Red Mountain formation consists of sandstone and shale, the former predominating, and there is no showing or record of ore. The outcrop of the formation becomes lower on the southeast slope of the ridge so that at the road toward Buford (Gilbert) ferry it is less than 100 feet above Coosa River. (Pl. 13B, 5) In this road outcrop the dips of the rocks are variable, indicating that the strata have been disturbed, which is to be expected, since the fault is near here. On this road there was noted a little debris of ferruginous sandstone such as occurs farther northeast.

Elliott Mountain.--On the southeast slope of the ridge which in this vicinity is called Elliott Mountain, about 1½ miles northeast of Gilbert ferry road there is much float of coarse grained, soft, dark red ore, somewhat slickensided, and of a finer grained more sandy ferruginous rock. The coarse grained material contains many specks of shale. Traces of two old debris filled prospects were noted from which ore had been thrown out. The maximum thickness of the ore fragments was 6 inches. In a small gully about 1½ miles northeast of the Gilbert Ferry road (Pl. 13B, 6) the following section was measured:

Section of ferruginous strata on southeast slope of Elliott Mountain about 3 miles south of Gadsden

	Ft.	In.
Shale		
Ore, coarse grained, soft		6
Sandstone, very ferruginous		5
Shale		1
Sandstone, very ferruginous		4
Shale		

Dip 21° N. 65° W. (a reversal from normal dip)

There is in the float some indication of another thin seam of ore 60 feet to 80 feet higher stratigraphically The sequence of the strata in the above section is similar to that in the "spread" of ore on Dunaway Mountain (Pl. 13B, 4) where ferruginous sandstone forms the lower part of a thin layer of ore.

A short distance west of Coosa River, south of Gadsden, near the Springville-Anniston quadrangle boundary line the outcrop of the Red Mountain formation terminates against the Cahaba fault and the next place where it appears again on the same strike toward the northeast is at Leeth Mountain, near Turkeytown, about 12 miles distant. (See pages 236-237.)

The following analyses are of ores, mostly soft, from Canoe Creek and Dunaway-Elliott mountains between Ashville and Gadsden:

No. Sample	Property	Met. Fe	Total Insol.	Mn.	P	S	Moisture
26767	Jas. Waddell	42.75	24.22	Trace	0.89	.09	1.20
26768	E. C. James	48.80	20.07	Do	.54	.07	1.60
26769	W. A. Willard	36.84	39.66	Do	.59	.06	1.00
26770	S. A. Willard	50.41	16.30	Do	.56	.06	1.20
26771	T. Baswell	49.35	19.96	Do	.43	.05	1.20
26772	Cornelie Iron Co.	54.90	12.30	Do	.40	.07	1.30
26773	W. T. Brown	47.94	22.82	Do	.48	.07	1.30
26774	Lacey-Beck	48.96	32.15	Do	.40	.07	1.30
26775	W. T. Brown	49.65	18.30	Do	.53	.07	1.40

Analysts: N. P. Pratt Laboratory, Atlanta, Ga., Apr. 17, 1906.

Oak Ridge and Beaver Creek Mountain

On the southeast side of Beaver Creek Valley and forming the northwest border of the Coosa Coal field is one of the longest northeast-southwest ridges in Alabama. It extends from near Odenville, St. Clair County, on the southwest to beyond Cannon Gap, in Calhoun County, on the northeast, a distance of about 45 miles, broken by comparatively few gaps. At the southwest this ridge is called Oak Ridge; opposite Ashville it is called

Beaver Creek Mountain, northeast of Coosa River for about 11 miles it is known as Greens Creek Mountain, and northeast of Davis Gap it is called Colvin Mountain. The Red Mountain formation extends along most of the length of this ridge gradually thinning out toward the southwest. It generally crops out near the crest of the northwest slope and occupies part of the southeast slope. This is the outcrop of the Red Mountain formation that lies farthest southeast in Alabama, for it does not come to the surface southeast of the Coosa Coal field. Several small pieces of ore float were noted in the valley on the southeast side of the ridge southeast of Odenville. The pieces were 1 to 2 inches thick, fossiliferous and of good quality. The outcrop of the ore bed was not seen.

Whatever iron ore there may be in Oak Ridge and Beaver Creek Mountain is considered to be of little value. It crops out in so very few places that the only special map presented for the area is Plate 14 which shows the approximate position of the ore bed in Greens Creek and Colvin Mountains. McCalley (M. II, p. 290) mentions that ore outcrops in sec. 22, T. 14 S, R. 4 E., were reported to him as not quite 2 feet thick. This locality is apparently somewhere near Looney Gap, about 4 miles southeast of Ashville. In the gap made by Coosa River at Greensport there is a good exposure of Chickamauga limestone, sandstones of the Red Mountain (?) formation and Fort Payne chert, but no iron ore is exposed. The operator of the ferry who had always lived at this place said that he knew of no bedded iron ore in this mountain. It is possible that the ore is absent throughout parts of this area because of nondeposition or else because of the outcrop being cut out by faults.

Greens Creek Mountain

Dodds Gap.—At Dodds Gap in Greens Creek Mountain, 4 miles northeast of Coosa River, at Greensport, there is debris of red iron ore on the southeast slope of the ridge. The rocks of the Red Mountain formation appear to have been broken and offset to the south by a cross fault at this place. Several prospect pits and trenches were noted on the hillside east of the highway which disclosed more than one seam of red ore. One of these seams exhibits a thickness of 3 feet 1 inch of fine-grained, siliceous red ore associated with sandy shale, the beds dipping 30° S. 65° E.

Fifty feet distant another pit shows 3 feet 6 inches of similar ore, but the dip is 25° N. 60° E., indicating that the beds have been broken into diverse attitudes by earth movements. The unusual thickness of the ore disclosed in the prospect may have been due to thrust faulting of the bed. This ore is soft on the outcrop and is locally reported to have shown on analysis 45 percent metallic iron. A short distance above this bed a seam crops out with a thickness of 4 inches to 6 inches of less siliceous, soft, oolitic ore. McCalley (M. II, p. 730) saw loose pieces of good ore scattered over the top of Greens Creek Mountain at Dodds Gap and mentions a report that three seams of ore occur here. He describes a 7-inch seam of good granular ore that occurs in the upper part of the formation between Dodds and Phillips Gaps, which, on analysis on a dried basis showed 53.15 percent iron, 16.68 percent silica, and 0.067 percent phosphorus.

Colvin Mountain

Phillips Gap.—In 1939 several small prospects were examined on the southeast side of the ridge about 250 feet southwest of the road through Phillips Gap (Pl. 14, 1). Two ferruginous beds separated by from 25 to 30 feet of shale and sandstone crop out in a small valley. The lower bed is composed of fine grains of quartz with a few well rounded quartz grains as large as peas, the whole cemented by hematite. It is about 1 foot, 8 inches thick, and breaks out in blocky pieces up to 10 inches thick. The upper bed is good fossiliferous ore in a single layer which varies from 4 to 6 inches in thickness, and is reported locally to be as much as 8 inches thick. The beds dip 20° S. 65° E.

Three beds of ferruginous material crop out in a small valley seven tenths of a mile northeast of Phillips Gap, but only the middle bed has been prospected recently (Pl. 14, 2). This bed measured 4 feet in thickness in the opening, and 10 inches more was reported locally to lie under debris at the bottom of the prospect. The bed is composed of ferruginous sandy shale which is full of small masses, patches, and thin coatings of oolitic hematite, the whole having a dull red color. The sandy seam mentioned in the paragraph above crops out 6 feet stratigraphically below, and the thin seam of better ore 20 feet stratigraphically above this ferruginous shale. The beds dip 20 S. 50° E. The ma-

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terial is apparently so low in iron as to be of doubtful value as an ore, and the extent to which the pattern of ore 2 feet or more in thickness should be drawn is mere guesswork.

The outcrop of a ferruginous bed, presumably the upper seam of good ore, can be traced from Phillips Gap northeastward for nearly two miles by old prospect trenches and pits. Over most of this distance the outcrop lies about halfway up the southeast side of the ridge, but to the northeast it trends towards the bottom of the ridge, finally disappearing under debris at the bottom of the valley. The ore beds crop out on both sides of the southwest segment of the ridge and can be traced to the northeast beyond Walker Gap by old trenches and pits. Beds of sandy ore crop out in horizontal position on the southwest ridge about 1 mile below Walker Gap (Pl. 14, 3).

Walker Gap.—At Walker Gap (Pl. 14, 4), about 2.6 miles northeast of Phillips Gap, red ore debris shows in abundance on the southeast slope of the mountain and the following section was measured by McCalley:

Sectin of iron ore outcrop at Walker Gap, western part of SE¼ sec. 12, T. 13 S., R. 6 E.

(M. II, p. 730)

	Ft.	In.
Ore, red, soft, very fossiliferous, seemingly of poor quality	3	
Sandstone	5	
Ore, red		6-9

McCalley (M. II, p. 732) mentions an ore seam said to be 12 inches thick at the Pryor mine that carried 51.66 percent metallic iron, 13.85 percent silica, 7.12 percent alumina, and 0.70 percent lime. The ore was, therefore, of the soft, or leached variety It was impossible to reconcile the location of the Pryor mine as given by McCalley, but information obtained from local residents indicated that the Pryor mine was actually near Walker Gap, probably in the SE¼ sec. 12, T. 13 S., R. 6 E., instead of on the east extension of Colvin Mountain, east of Rock Springs as stated in McCalley's report. The location of the old Laney openings are probably in sec. 34, T. 12 S., R. 7 E., on Colvin Mountain about 1 mile east of Rock Springs.

Field work and examination of aerial photographs by Andrews indicate the absence of any large-scale faulting in the Walker Gap area. The structure appears to be due to a transverse fold which has produced a shallow syncline in the northwest segment of the ridge and an anticline in the southeast segment. The two folds plunge slightly to the southwest and are probably faulted along their axes.

About 1 mile northeast of Walker Gap there were reported to McCalley the outcrops of five different seams of red ore, but only one was seen by him in place, a very poor, siliceous ore, about 1 foot 2 inches thick. An average sample of the well leached, or soft, ore, analyzed on a dried basis showed (M. II, p. 731) 36.67 percent iron, 42.66 percent silica, and 0.144 percent phosphorus. Debris of another seam was reported as seen higher up on the mountain, in slabs 6 to 8 inches thick of good quality ore.

Davis Gap.—From Walker Gap to the northeast beyond the sharp bend near Davis Gap (Pl. 14, 5) the ore bed can be traced by old workings until it disappears under debris in the synclinal area west of Rock Springs. Ore on the dumps indicates a thin bed of good fossiliferous ore with clay streaks and clay lenses, and with considerable quartz grit. From the few exposures available for measuring the ore bed seemed to average 10 inches or less in thickness. Debris of the lower sandy seam was scattered over the surface but no good exposures were seen.

One mile southeast of Davis Gap on the west side of the ridge a small prospect was examined by Andrews in 1940. About 2 feet of ferruginous sandstone composed of well rounded quartz grains cemented by hematite were exposed in the opening. The beds are much jointed and faulted within the prospect pit, but seemed to dip about 35° S. 60° E. Along the crest of the high ridge (Pl. 14, 6) 1.5 mile southeast of Davis Gap debris of fossiliferous porous ore of fair grade was seen, but no prospects or outcrops of the bed could be found.

Greens Creek Mountain is sinuous from Phillips Gap to its end west of Rock Springs and there is a parallel overlap of two segments of the ridge 3 miles in length southeast of Glencoe due to faulting. The Red Mountain formation terminates 1 mile southeast of Glencoe against a fault about 1/3 mile south-southwest of Rock Springs.

Rock Springs.—The axis of this series of mountains is thrown completely out of line by two north-south faults near Rock Springs (see Pl. 14, this report, also the geologic map, Special Report No. 14, Geological Survey of Alabama). This dislocation of the strata has produced the deep north-south cove about 3 miles in length through which the Louisville and Nashville Railroad passes and emerges at the head of the cove through a tunnel near the village of Laney. This tunnel is considered to be in sandstone and shale of the Red Mountain formation which have suffered deformation with offsets of beds and varying dips.

According to McCalley (M. II, p. 731), a seam of ore exposed in the cut approaching the southeast end of the Louisville and Nashville Railroad tunnel (Pl. 14, 7) ranges from 8 inches to 1 foot 3 inches in thickness.

On the east side of the north-south strip of Colvin Mountain there is much debris of red ore, some of it of good quality in brick-like blocks, and some of poor, sandy ferruginous material, as if from separate seams. The sandy ore crops out in the SW¼ SE¼ sec. 34, T. 12 S., R. 7 E., in two ledges, respectively about 4 and 8 inches thick separated by 1 to 2 inches of shale. An average sample of the block and boulder ore dried at 100° C. gave the following analysis: (M. II, p. 732) iron, 40.56 percent; silica, 35.89 percent; phosphorus, 0.099 percent

In 1940, the junior author walked the outcrop of the Red Mountain formation in Colvin Mountain from the gap on the local road east of Cobb to Colvin Gap. Abundant debris of sandy ore was seen on the east slope of the north-south ridge as noted by McCalley (M. II, p. 732). An old prospect near the crest of the ridge in the vicinity of Cobb (Pl. 14, 8) showed from 2 to 3 feet of ferruginous sandstone dipping about 30° north. About 1 mile southeast of Rock Springs old trenches on the outcrop of the upper bed were found on a spur of the main ridge and were followed to a point 1 mile directly east of Rock Springs (Pl. 14, 9). Here in a trench and in a short drift driven into the hill to the northeast two beds of ore are well exposed. These workings belong to the group called the "Laney openings" by McCalley. The section is as follows:

Section of iron ore beds 1 mile east of Rock Springs

	Feet	Inches
Shale		
Ore, good, fossiliferous		10
Shale and sandstone, approximately	25	
Shale and ferruginous sandstone	1	6
Sandstone, ferruginous, one stratum	1	7
Shale		3
Sandstone, ferruginous		9
Clay parting		1
Ore, lean, sandy, friable, shaly	2±	

Dip 21° S. 80° E. Total ore, good and poor, about 2 feet, 10 inches.

The following percentages given by McCalley (M. II, p. 751) indicate a low grade of ore at the Laney mine: Iron, 32.76; silica, 34.55; alumina, 9.14; lime, 0.30; phosphorus, 0.36; sulphur, trace.

From the above locality to Colvin Gap the outcrop of the upper bed can be followed over most of the distance by shallow old workings. No evidence was found of a good ore bed thicker than 10 inches.

Colvin and Cannon Gaps.--At Colvin Gap sandstone and shale of the Red Mountain formation make up the northwest slope of Colvin Mountain and extend a short distance down the southeast slope. On the road near the crest fragments of iron ore 2½ inches to 1 foot thick were noted. Some of the ore is in thin, dark red, granular blocks of high specific gravity, but other pieces seem to come from a thicker coarse, sandy seam. The dip here is 25° to 30° S. 20° E. McCalley (II, p. 234 and p. 733) mentions that an ore bed near here is said to be 3 feet 6 inches thick, but he apparently believed that the ore was in three seams from 7 inches to 1 foot 2 inches thick.

At Cannon Gap, about 3½ miles east of Colvin Gap, and eight-tenths of a mile east of the border of Plate 14, the crest of the ridge is formed by heavy sandstone of the Red Mountain formation. The only evidence of ore noted here were a few fragments similar to the better ore at Colvin Gap, but only about 1 inch thick. Shale of the Red Mountain formation here dips 25° to 28° S. 20° W. and passes beneath a fine quartz conglomerate, proba-

bly Devonian in age, which is overlain by argillaceous limestone, which stratigraphically higher becomes cherty and in all probability represents the Fort Payne chert.

The strip of Red Mountain formation terminates at the east near the northwest corner of Township 13 S., Range 9 E., in the promontory in Calhoun County about a mile southeast of where Etowah, Cherokee and Calhoun Counties come together. McCalley (II, pp. 733-735) has discussed supposed extensions of the Red Mountain formation around the head of Ohatchee Creek and along the southeast border of the valley of that creek, but it is the belief of more recent investigators[1] that the sandstone beds formerly considered to be of Silurian age in those localities and southwestward along the southeast border of the Coosa Coal field are in reality of Devonian age.

In reviewing the evidences of red iron ore in the strip of Red Mountain formation that extends along, and in fact forms the crest of the Beaver Creek-Greens Creek-Colvin Mountains, it is found that there have been more rumors of, than actual observations of, iron ore beds of sufficient thickness and good enough quality to be of commercial interest. The thickness of 3 feet 6 inches measured at Dodds Gap is probably exceptional, and may represent a local thickening by thrust faulting and squeezing. Fifty feet away it is 5 inches less and nowhere else in the vicinity did it appear as great. Moreover, the beds are so jumbled about by faulting here as to be difficult to follow for any considerable distance, and a soft ore yielding only 45 percent of iron would not grade into a good hard ore with depth. Apparently the only places where soft ore actually was mined were at the Pryor openings near Walker Gap, at the Quinn (?) openings in sec. 5 (?), T. 13 S., R. 7 E., and at the Laney openings about 1 mile east of Rock Springs, although there are short trenches on ore beds from place to place in addition to these. The three ferruginous beds in this strip comprise a lower siliceous bed, a middle shaly bed, and an upper thin bed. The lower bed, which may be as thick as 3 feet 6 inches, where soft, is reported to yield only 45 percent of iron and would not grade into a good hard ore at depth. The middle bed, ranging in thickness from 3 feet, 6 inches to 4 feet,

[1]Butts, Chas., Geology of Alabama, Geological Survey of Alabama, Special Report 14 with latest geologic map, 1926.

10 inches is in reality a ferruginous shale. The analysis of ore reported by McCalley from the Laney openings presumably was made on material from this bed. The upper seam, not more than 10 inches thick, is of good quality but too thin to be worked underground. If it were feasible to obtain some soft ore from the beds in this strip the problem of transportation would not be insurmountable as the distance by road to Coosa River at Greensport from Dodds Gap is about 4½ miles, and from the Seaboard Air Line at Ohatchee it is about 7 miles. The Louisville and Nashville Railroad passes through Colvin Mountain in a tunnel south of Rock Springs, and is thus not far from the old Laney openings. The nearest blast furnace is at Gadsden, only about 10 miles from Rock Springs via the above-mentioned railroad.

Resume of iron ore reserve in the Greens Creek-Colvin Mountain area

The approximate length of outcrop of iron ore beds 2 feet or more thick on Greens Creek Mountain between Dodds Gap and Walker Gap and a short distance on Colvin Mountain near Rock Springs is about 1 mile, or 5,280 feet. The average width of workable ore down the dip is placed at 400 feet. The average thickness of the ore bed appears to be about 2.9 feet. The estimated total quantity of recoverable soft, semihard, and hard ore appears to be approximately 813,000 long tons.

BROWNS VALLEY

(Plate 1)

General Statement. — A long, narrow, northeast - southwest trending valley has been developed by stream erosion along an anticlinal axis in northern Alabama and southern Tennessee. Tennessee River flows southwestward in this valley from South Pittsburg, Tenn., to Guntersville, Ala., entering the valley from the gorge it has cut through the nearly flat rocks of Walden Ridge, or Sand Mountain, in Tennessee below Chattanooga, and leaving it abruptly at Guntersville where it swings northwestward into another area of nearly flat rocks. The northeastern, or Tennessee portion of this long, narrow anticlinal valley is occupied by Sequatchie River, which flows southwestward into Tennessee River; southwest of Guntersville it is occupied by Browns Creek, flowing northeastward into Tennessee River, and from this creek is derived the name applied to the whole of the valley in Alabama. Browns Valley has a total length from the head of Brown's Creek northeastward to the Alabama-Tennessee line of about 75 miles and a width generally of 4 to 5 miles It extends across portions of the Stevenson, Scottsboro, and Gadsden quadrangles. The Southern Railway extends through Browns Valley between Bridgeport and Scottsboro. Below Scottsboro supplies are transported largely via Tennessee River.

The geologic structure of Browns Valley is such that the rocks on the southeast side of the anticline lie in normal sequence and dip at moderate angles to the southeast, while the rocks on the northwest side have for long distances been faulted so that the older rocks have been brought up against the younger rocks or slightly thrust over them. The Red Mountain formation crops out apparently in an unbroken strip, except where buried by river alluvium, along the southeast side of the valley from the Alabama-Tennessee State line to the head of Browns Valley near Brooksville, beyond which toward the southwest there are inliers of the formation along the axis of the anticline near Blountsville and Blount Springs. Its outcrop is marked for the most part by a low ridge or a line of low knobs. As a result of faulting this formation has been buried on the northwest side of Brown's Valley from the State line nearly to Scottsboro. From Scottsboro southwestward the formation apparently outcrops on the northwest side

of Browns Valley, except where the rocks are buried by Tennessee [illegible] [illegible] 7 miles [illegible] Guntersville and [illegible] Hill [illegible] continuous around the head of the valley. The general distribution of the Red Mountain formation in Browns Valley is shown in Plate 1 of this report and on the Geologic Map of Alabama, Special Report 14, 1926 [illegible] is shown on the larger scale geologic maps [illegible] Folios No. [illegible] and 35 respectively [illegible] U. S. Geological Survey. No detailed map of Browns Valley has been published in this report because no [illegible] has been found. The richest material [illegible] is a ferruginous limestone containing generally less than 25 per cent of metallic iron.

The Geological Survey of Alabama, represented by Mr. Henry McCalley, Assistant State Geologist, made a detailed examination of the [illegible] strata in this portion of Alabama, the results of which were published in Part I of the report on the Valley Regions of Alabama in 1896.[1] In 1928 a trip through Browns Valley was made by the senior author of this report for the purpose of examining some of the sections observed by McCalley and to [illegible] notes on other [illegible] of ore-bearing beds without, however, duplicating much of the painstaking field work already performed by McCalley. Notes [illegible] along the southeast side of the valley will be given here incorporating many sections published by McCalley.

Southeast border of Browns Valley

Bridgeport. The Red Mountain formation along the southeast [illegible] of Browns Valley is [illegible] feet thick and in places [illegible] ferruginous beds have been noted. These beds are called by McCalley the "top seam," the "big seam," and the "sandy seam." The general character of the formation on the southeast side of the valley in the vicinity of Bridgeport is shown in the following [illegible] sections. Most of McCalley's sections have been edited slightly in order to condense them.

[1] [illegible] Henry McCalley [illegible] the valley regions of Alabama, Pt. I, [illegible] 1896, [illegible] this report as (M. I, [illegible])

Partial section of Red Mountain formation in the N½ NE¼ sec. 2, T. 1 S., R. 9 E., near the State line

(M. I, p. 284)

	Ft.
(7) Limestone, ferruginous limestone; in thin ledges; one of the ledges near the top is the ore seam, about	80
(6) Ferruginous limestone, the "big ore seam," dip about 20° SE	8-10
(5) Debris, soil with loose pieces of yellow calcareous sandstone	20-25
(4) Soil	50-60
(3) Red streak	1
(2) Shale, yellow	4-5
(1) Red streak	4

Analyses (see page .. No. 1) showed a content of 19.67 per cent of metallic iron in the "top ore seam," which was 10 inches thick. The "big seam," the ferruginous limestone, showed only 1.12 per cent to 2.45 per cent of metallic iron.

Traverses between the State line and Carpenter along the ridge containing rocks of the Red Mountain formation indicated that the nearest approach to a seam of ore was a hard ferruginous sandstone, 3 to 4 inches thick of dark red color, but carrying only a low percentage of metallic iron.

Partial section of Red Mountain formation southeast of Carpenter Station, in the NW¼ sec. 11, T. 1 S., R. 9 E.

(M. I, p. 285)

	Ft.	In.
(18) Loose fossil chert; nodules about the size of one's fist, covering completely the steep portion of hill	40-50	
(17) Shale, yellowish and in beds; loose, flaggy, ferruginous sandstone and chert, about	150	
(16) Ferruginous limestone, hard and very fossiliferous, the "big seam"; dip 15° to 20° SE. About	4	

(15) Debris, siliceous limestone; debris with loost pieces of hard ferruginous limestone and layers of siliceous, dirty yellow limestone. About	20	
(14) Sandy or siliceous limestone; generally weathered to yellow sandstone, the limy matter having been leached out; shaly near bottom	3	
(13) Debris	5	
(12) Sandy or siliceous, dirty yellowish limestone	1	
(11) Debris	4	
(10) Sandy or siliceous, dirty yellowish limestone, a little ferruginous in places	3	
(9) Debris, about	20	
(8) Limestone, gray, hard and fossiliferous; breaks up into irregular lumps	4	
(7) Debris	3	
(6) Limestone, in hard layers 2 to 4 inches in thickness	1	6
(5) Debris	4	
(4) Limestone, like (8)	6	
(3) Debris, alternating with layers of sandy or siliceous dark yellowish ashy gray limestone	15	
(2) Soft "ore," shaly, visible to a thickness of about		10
(1) Debris		

An analysis of material from No. 16, the "big seam," showed only 1.91 per cent metallic iron.

Partial section of Red Mountain formation northeast of Bridgeport, in the NW¼ NE¼ sec. 15, T. 1 S., R. 9 E.

(M. I, p. 287)

		Ft.
(11)	Loose fossiliferous chert	
(10)	Shale, limestone; greenish yellow calcareous shale with thin seams of very hard siliceous limestone, about	35
(9)	Red loam, a sandy clay	20
(8)	Ferruginous limestone, variegated, very fossiliferous	4
(7)	Red loam	5
(6)	Sandstone, dark gray, with small red flakes, visible	1
(5)	Red loam	5
(4)	Limestone, shaly and fossiliferous and of light dove color, visible	1
(3)	Red loam	6
(2)	Sandstone, dirty grayish color, weathers shaly	15
(1)	Limestone, blue and dove colored, massive, shaly and fossiliferous	15

Partial section of Red Mountain formation southeast of Bridgeport, in the SW¼ SW¼ sec. 21, T. 1 S., R. 9 E.

(M. I, p. 287)

		Ft.	In.
(7)	Sandstone, yellowish, in thick blocks	3	
(6)	Red "ore," shaly		6
(5)	Debris, about	1	6
(4)	Limestone, ferruginous, with splotches of good ore, the "big seam"	3	
(3)	Debris and yellow shale	20	
(2)	Limestone, hard, gray, fossiliferous	4	
(1)	Shale		

In the NE¼ SW¼ sec. 21, T. 1 S., R. 9 E., the "upper" and "big" seams were noted about 50 feet apart with the "sandy" seam about 30 feet lower. None of the seams carries more than a few per cent of iron.

Widow Creek.—Tennessee River crosses the outcrop of the Red Mountain formation below Bridgeport and flows on the southeast side of the ridge for a distance of about 4 miles, crossing back to the northwest side near the mouth of Widow Creek. On the Island Creek Ferry road both the "big" and "sandy" seams outcrop. A specimen from the "big" seam collected by C. W. Hayes in 1888 during the survey of the Stevenson quadrangle, north of Island Creek Ferry is a chocolate-colored ferruginous, highly fossiliferous limestone. Thin films and lenses of finely granular hematite are scattered through it, but the content of iron probably would not exceed 5 per cent. (See analysis No. 24592, page 315.)

Partial section of Red Mountain formation above the mouth of Widow Creek, in the SW¼ NE¼ sec. 1, T. 2 S., R. 8 E.

(M. I, p. 289)

	Ft.
(4) Limestone, siliceous and a little ferruginous the "big seam"	4
(3) Debris	3
(2) Limestone, ferruginous, massive, with irregular prominent sandy streaks or seams	5
(1) Limestone, hard, gray, in beds 2 to 3 feet in thickness; forms a bluff	30

The latest observations of the Red Mountain formation in this vicinity were made by the two authors of this report on June 27, 1942. At this time an outcrop in a cliff facing southeast toward Tennessee River was seen (See Fig. 13A) which showed the following section:

Section of ferruginous part of Red Mountain formation on northwest bank of Tennessee River about ½ mile above mouth of Widow Creek.

	Ft.	In.
Soil		
Limestone	3	6
Limestone, massive, ferruginous	3	3
	to	
	3	6
Limestone, fossiliferous, becoming shaly in lower part	3	
Soil and debris		

Dip about 10° S. 45 E.

Fig. 13A. Ledge of ferruginous limestone on northwest bank of Tennessee River about one half mile above mouth of Widow Creek, (below Bridgeport.)

Fig. 13B. Shaly and sandy ferruginous beds in Red Mountain formation at Guntersville.

In general the thickness of the ferruginous bed measured as indicated above but in one place at which the ferruginous condition extended up into the limestone beds above the total thickness of ferruginous material reached 4 feet to 4 feet 2 inches. The ferruginous bed probably corresponds to the "Big Seam", No. 4, of the section above cited from McCalley.

The dip of the rock indicates that these beds may also crop out near the top of the northwest slope of the ridge. The surface there is covered but several slabs of ferruginous limestone, partly altered t limonite, were noted on that slope. In view of analysis R. 5, p. 315, this material is not valuable as an iron ore or as fluxing stone.

Fabius.—On the southeast side of Tennessee River and below Caperton Ferry some thin, loose fragments of ferruginous lime stone were noted, and it was reported by old settlers that thin seams of very red "dye stone" occur in this vicinity, pieces of which were used many years ago to dye thread and yarn. It is probable that the material so used was the leached outcropping material from ferruginous limestone beds pretty much all of which was gathered up for the purpose of making dye stuffs. A section of an outcrop south of Stevenson by McCalley is as follows:

Partial section of Red Mountain formation in the NW¼ NW¼ sec. 8, *T.* 3 *S., R.* 8 *E.*
(M. I, p. 290)

	Ft.	In.
(8) Debris; soil with loose pieces of very hard dirty yellow sandy or siliceous limestone, a little ferruginous in places and has numerous cavities lined with quartz crystals. This debris extends down to a bench covered with a growth of red cedar	35	
(7) Limestone, sandy, dirty yellowish gray, and debris; the limestone is in layers with the debris between them	40	
(6) Debris	50	
(5) Ferruginous limestone, "big seam," forms bluff	12	
(4) Debris of loose rock and soil, believed to cover principally a yellowish shale	30	
(3) Limestone, grayish yellow	1	6
(2) Limestone, ferruginous, carries less iron than (5), contains sandy seams that stick out prominently from the weathered outcrops, especially from the lower 8 feet	15	
(1) Debris; to river bottom	15	

An analysis showed that the ferruginous limestone of No. 5 in the section contained 2.86 per cent metallic iron. A more detailed section of the ferruginous limestone, No. 5 of the above section, is as follows:

Section of ferruginous limestone in the NW¼ SW¼ sec. 8, *T.* 3 *S., R.* 8 *E.*
(M. I, p. 291)

	Ft.	In.
(4) Shale, reddish and clayey, with seams of ferruginous, hard limestone that break up into rough, friable lumps 4 to 5 inches in diameter	1	1
(3) Ferruginous limestone; a limy ore, the "big seam," hard, granular, and friable, breaking up into coarse lumps or balls	2	
(2) Ferruginous limestone, less ferruginous than (3)	12	
(1) Debris		

An average sample of about 40 pieces taken from bed No. 3 of this ferruginous limestone showed 3.36 per cent of metallic iron.

Coffeys Ferry.—Exposures of Red Mountain formation in a hill about 1½ miles northeast of Coffeys Ferry showed shale, sandstone, and ferruginous fossiliferous limestone, about 1 foot thick, but no iron ore.

From the mouth of Widow Creek nearly to Coffeys Ferry, a distance of 10 miles, Tennessee River flows on the northwest side of the ridge containing the Red Mountain formation. Just above Coffeys Ferry the river cuts through the ridge again and its course for the next 18 miles, or to Larkins Landing, in the Scottsboro quadrangle, is on the southeast side of the Red Mountain outcrop. Nothing richer than ferruginous sandstone and limestone has been observed in this strip of the formation. The "Red Hills," northeast and southwest of the road leading to Coffeys Ferry from the northwest contain shale of the Red Mountain formation with thin beds of dark red ferruginous sandstone containing streaks about 1/8 inch thick in which an appreciable proportion of iron oxide is visible.

Bellefonte Island.—One-half mile north of Bellefonte Island McCalley noted the following section:

Section of "big seam," near Bellefonte Island, in the NE¼ sec. 33, T. 3 S., R. 7 E.
(M. I. p. 293)

	Ft.
(4) Sandy or siliceous limestone; massive, consisting of interstratified irregular sandy seams that are prominent and separated from each other by thinner seams of purer limestone	8
(3) Loose black ferruginous sand or soft black ferruginous sandstone	4
(2) Ferruginous limestone; hard and compact, shaly in places	7
(1) Debris	

In the same vicinity a little to the southwest of the point where the above section was made a test pit about 20 feet deep was dug in search of ore. Apparently only yellowish and red shale was found.

Scottsboro Bridge.—Outcrops of the Red Mountain formation were examined on the roads leading to the abandoned Sublette and Hales Ferries and near the new bridge over which State Highway No. 35 crosses Tennessee River. Only yellowish shale marked the outcrop of the Red Mountain formation here. About 3 miles southeast of Scottsboro near the west edge of the Stevenson quadrangle the following section was measured by McCalley:

Partial section of Red Mountain formation in the NW¼ SE¼ sec. 4, T. 5 S., R. 6 E.
(M. I, p. 297)

	Ft.
(3) Ferruginous black sandstone and sand and yellow shale, in interstratified seams	20
(2) Shale, yellow	8
(1) Limestone, gray	

On the south bank of Roseberry Creek, about three-quarters of a mile from the mouth, McCalley noted an outcrop of ferruginous limestone in three streaks, each 2 inches to 3 inches thick separated by interstratified seams of shale about 3 feet each in thickness, and he regards these as representing the "big seam.' Other streaks of ferruginous limestone also outcrop lower in the formation. Below the mouth of Roseberry Creek he observed the following section:

Partial section of Red Mountain formation in the NE¼ NW¼ sec. 17, T. 5 S., R. 6 E.
(M. I, p. 298)

	Ft.	In.
(6) Shale, yellow, with interstratified streaks of loose ferruginous sand	8	
(5) Ferruginous limestone, hard	3	
(4) Shale, yellow	1	6
(3) Ferruginous, loose black sand	5	
(2) Limestone, yellowish-gray, flaggy	4	
(1) Ferruginous black sandstone debris	30	

In the gap of the low ridge 1 mile north of Section Ferry, shale of the Red Mountain formation is exposed in a ditch 100 feet northeast of the road, but no ferruginous material is visible.

On the road to the abandoned Caldwell Ferry yellowish shale of the Red Mountain formation is well exposed northwest of the ridge. The shale dips 13° to 15° toward the southeast and contains a streak of soft red hematite, 1 inch to 4 inches thick. The creek shows much iron rust.

Between the location of the abandoned Caldwell Ferry and Larkins Landing some float pieces of ferruginous sandstone have been noted and the ferruginous limestone, or "big seam, outcrops in two strata as shown by the following sections by McCalley:

(a) *Section of "big seam" in the NE¼ SE¼ sec.* 19, *T.* 5 *S., R.* 6 *E.*

(M. I, p. 299)

	Ft.
(4) Ferruginous limestone, hard	2
(3) Shale, yellow	3
(2) Ferruginous limestone, hard	4
(1) Shale, yellow	

(b) *Section of "big seam" in the NE¼ SE¼ sec.* 19, *T.* 5 *S., R.* 6 *E.*

(M. I, p. 299)

(About 75 yards southwest of location of section (a))

	Ft.	In.
(5) Debris		
(4) Ferruginous limestone, hard, forms bluff	5	
(3) Debris	1	6
(2) Ferruginous limestone, hard and compact, forms bluff	5	
(1) Debris		

An average sample consisting of about 25 pieces of more or less ferruginous limestone taken by McCalley from beds 2 and 4 in each of the above two sections showed on analysis 9.39 per cent of metallic iron (Page 314, analysis No. 2).

Larkin Landing.—Near the west bank of Tennessee River about one-quarter of a mile above Larkin Landing the following section was measured:

Partial section of Red Mountain formation in the SW¼ SE¼ sec. 19, *T.* 5 *S., R.* 6 *E.*
(M. I, p. 300)

	Ft.
(5) Ferruginous limestone	11
(4) Debris	3
(3) Ferruginous limestone	3
(2) Debris	3
(1) Bluff of limestone, siliceous, and in upper part a little ferruginous; and shale, siliceous and variegated forming interstratified seams in the limestone	80

The upper limestone bed is reported to be the most ferruginous of the three. The general dip of the beds in this locality is about 20° S. 40° E.

The Red Mountain formation is crossed about ½ mile above Larkins Landing by the Tennessee River, which bends to the west and swings nearly across the valley. In this vicinity in places the bedded rocks are obscured by deposits of loam and flinty gravel. Northeast of the landing the Chickamauga limestone extends from river level to the top of the hill, with a dip of 7° to 10° S. 40° to 45° E. Fine examples of ripple marked limestone are exposed just above the river. In the hills about 1 mile northeast of the ferry the Red Mountain formation contains thin seams of very ferruginous sandstone, but no true iron ore.

Langston.—Just northwest of Langston the following section was made by McCalley:

Sections of "big seam" in the SW¼ SE¼ sec. 35, *T.* 5 *S., R.* 5 *E.*
(M. I, p. 301)

	Ft.
(6) Sandstone	
(5) Ore (?)	4-5
(4) Debris; holding piece of dark sandy ore	12
(3) Limy or hard ore	5
(2) Ore, bluff, does not carry over 10 per cent of iron	5
(1) Debris	

It is unfortunate that the term "ore" should have been used in connection with any of these beds.

West of Langston the Red Mountain formation is exposed in a narrow outcrop area on the northwest slope of the ridge, and contains a seam of soft, dirty ore, 11 inches thick, dipping toward the southeast. In the southern part of the Scottsboro quadrangle below Langston and the northern part of the Gadsden quadrangle the exposures of the Red Mountain formation consist largely of yellow fissile shale carrying thin seams of dark red, very ferruginous sandstone in the upper half. In one place these seams aggregate 3 feet to 4 feet thick but are parted by limy beds. Under a field lens this ferruginous sandstone appears to be composed of 80 to 90 per cent of fine, rounded to subangular quartz grains, coated and cemented by hematite. One bed about 4 feet thick, containing some ferruginous matter, probably McCalley's "big seam," was noted. A section by McCalley near the Hillian store is as follows:

Section of "middle or big seam," in the northeast corner of the SE¼ NE¼ sec. 20, T. 6 S., R. 5 E.

(M. I, p. 338)

	Ft.
Shales, yellowish	
(4) Ore, hard, limy	4
(3) Ferruginous limestone	6
(2) Debris	4
(1) Ferruginous limestone	8

The most ferruginous bed was No. 4 and bed 1 was the least ferruginous. An analysis of an average sample collected by McCalley consisting of about 25 pieces from the upper 14 feet of the "big seam" showed only about 1.81 per cent metallic iron. In this same vicinity at a higher altitude McCalley found an outcrop of the "top seam" 8 inches thick, an average sample of which showed 13.25 per cent metallic iron (p. 314, analysis 3). Another average sample from the upper 14 feet of the "big seam," also in sec. 20, showed 4.7 per cent metallic iron. As this bed is traced to the southwest it is found to change but little in general character, varying from place to place in thickness and content of iron, but nowhere carrying sufficient iron to be regarded as an ore. In the NW¼ SE¼ sec. 30, T. 6 S., R. 5 E., the upper 4 feet of the "big seam" was observed to be the most ferruginous part of the bed, and on analysis it proved to carry 11.65 per cent metallic iron (p. 314, analysis 4).

Meltonsville.—One-half mile northwest of Meltonsville, shale and sandstone of the Red Mountain formation are exposed in an old road, but no ore was present either in place or as float. The following section was made by McCalley in this vicinity:

Section of "big seam" in the northwest corner of sec. 1, T. 7 S., R. 4 E.
(M. I. p. 341)

	Ft.	In.
(7) Sandstone, yellowish and massive		
(6) Ferruginous limestone, hard and massive	4	
(5) Debris	3	
(4) Ferruginous limestone, hard and massive with interstratified sandy streaks; forms bluff	6	
(3) Sandy ore, soft and friable, well leached	1	6
(2) Debris	3	
(1) Ferruginous chert, limestone		

An average sample from the ferruginous limestone beds 4 and 6 of the above section showed 5.32 per cent metallic iron, and an average sample of the "top seam," which in this locality is about 8 inches thick, showed, according to McCalley, 12.69 per cent metallic iron (p. 314, analysis 3. Southwest of Meltonsville McCalley observed the following section:

Partial section of Red Mountain formation in the NE¼ SW¼ sec. 11, T. 7 S., R. 4 E.
(M. I, p. 343)

	Ft.	In.
(8) Ferruginous limestone, "top seam"		8
(7) Limestone, yellowish, sandy, slabby	45	
(6) Sandstone, massive, in blocks	4	
(5) Ferruginous limestone, shaly in places	3	
(4) Shale		6
(3) Ferruginous limestone, massive; forms bluff	8	
(2) Shale, yellowish	5	
(1) Sandy ore in soft streaks interstratified with shale	3	

An average sample of the ferruginous limestone Nos. 3 and 5 showed on analysis 8.07 per cent metallic iron. McCalley states that the upper stratum of the "big seam" outcrops in the SW¼ NE¼ sec. 15, T. 7 S., R 4 E., as a 5-foot bluff, an average sample

of which showed on analysis 16.93 per cent metallic iron (p. 314, analysis 6).

Buck Island.—The Red Mountain formation is crossed again by Tennessee River at Buck Island and from there nearly to Guntersville, a distance of about 4 miles, the river flows southeast of the ridge. Near the river the following section was made by McCalley:

Partial section of Red Mountain formation in Tennessee River bluff in the NE¼ SE¼ sec. 19, T. 7 S., R. 4 E.
(M. I, p. 344)

	Feet
(6) Sandstone, yellowish and reddish	...
(5) Ferruginous limestone, siliceous	5
(4) Ferruginous limestone, with irregular interstratified sandy streaks	10
(3) Ferruginous limestone, massive and granular, a little shaly on top, forms the main bluff	20
(2) Limestone, ashy gray, breaks up usually into irregular pieces though sometimes into slabs, cherty in places	35
(1) Limestone, yellowish gray, argillaceous	

Only 2.38 per cent metallic iron was found in the ferruginous limestone beds 3 to 6 inclusive. It appears possible that McCalley has here included ferruginous limestone beds belonging to the Chickamauga limestone. The next section toward the southwest measured by McCalley is as follows:

Partial section of Red Mountain formation in the NE¼ NE¼ sec. 30, T. 7 S., R. 4 E.
(M. I, p. 346)

	Ft.	In.
(7) Ferruginous limestone ledge		6-8
(6) Shale, yellowish	1	6
(5) Ferruginous limestone ledge		8
(4) Shale and thin bedded sandstone, yellowish	20	0
(3) Sandstone, massive, yellow	10	
(2) Sandy ore or ferruginous sandstone, soft, or well leached	5	
(1) Ferruginous gray limestone, granular, though hard and compact with calcite streaks and specks	20	

The metallic iron contained in the ferruginous limestone No. 1 amounted to only 1.96 per cent. A section of the "top seam" by McCalley is as follows:

Section of "top seam," in the southwest corner of sec. 30, T. 7 S., R. 4 E.
(M. I, p. 347)

	Ft.	In.
(5) Ferruginous limestone ledge		6
(4) Debris	1-1½	
(3) Ferruginous limestone, ledge		6
(2) Limestone, yellowish and sandy	3	
(1) Ferruginous limestone		6

The lowest limestone, No. 1, is more ferruginous than (3) or (5). In this vicinity, southeast of "North" the "Rockwood" or Red Mountain formation appears to have been mapped in the Gadsden folio too far toward the northwest. The Chickamauga limestone here extends almost to the southeast border of the ridge and probably has been mapped partly as "Rockwood," or Red Mountain formation. No ore was found in a good section exposed by a creek that cuts nearly through the ridge. Manganiferous chert of the Fort Payne chert was noted here.

Guntersville.—On the northwest side of the ridge at Guntersville there is a good exposure of a large part of the Red Mountain formation. A section as given by McCalley is as follows:

Partial section of Red Mountain formation at Guntersville
(M. I, p. 348)

	Ft.	In.
(9) Devonian shale		
(8) Shale, sandstone, yellowish; shaly, dove-colored limestone; and very hard ferruginous limestone in thin irregular streaks	25	
(7) Ferruginous limestone ledge		6
(6) Debris; doubtless covers shale	1	6
(5) Ferruginous limestone ledge	1	
(4) Yellowish shale and sandstone with in places a massive gray siliceous limestone	50	
(3) Ferruginous limestone, shale	20	
(2) Shale, limestone, debris	45	
(1) Limestone, argillaceous, with reddish and pinkish ferruginous splotches, "calico rock"	20	

A more detailed section of the "big seam" as given by McCalley is as follows:

Section of "middle or big seam" at Guntersville
(M. I, pp. 348-349)

	Ft.
(3) Ferruginous, black sand and clay in interstratified streaks	8
(2) Shale, argillaceous, yellowish and bluish	6
(1) Ferruginous, loose black sand with shale in streaks near bottom	6

Analyses of average samples of the ferruginous limestone and ferruginous sand, derived by the leaching of ferruginous, siliceous limestone, from this locality cited by McCalley showed 11.72 per cent and 22.75 per cent metallic iron respectively (p. 314, analyses 7 and 8). The last percentage is the highest per cent of metallic iron yielded by the "big seam" at any point in Browns Valley.

Two ferruginous beds crop out on the north side of a ravine in the ridge in the northwest part of Guntersville, one about 1 foot 8 inches thick and another about 5 feet thick 4 or 5 feet below the smaller one, both belonging to the "big seam." In detail they consist chiefly of alternating seams of hard and soft ferruginous sandy material ranging generally from one-half inch to 4½ inches thick, although a thickness of 8 inches was noted in one soft seam and of 11 inches in one hard seam. The soft seams probably represent the weathered edges of the more argillaceous layers while the harder ones are the more siliceous. The color of the material is dark brownish-red due to specks and streaks of hematite and limonite. Some limy beds containing streaks of fine-grained hematite of the "flaxseed" type also are present. These exposures evidently represent those given in the preceding section by McCalley. The ferruginous bed is full of finely comminuted fossil remains and is typically of the Red Mountain formation. It seems to represent an unusual thickness and higher percentage of ferruginous material than is normal in Browns Valley, but its content of silica and alumina is so high as to rule it out of consideration as an iron ore. The thinner ferruginous bed, 1 to 2 feet thick, crops out also on the south side of the ravine where some prospect cuts have been made, and it may be traced up the slope of the ridge toward the west.

About 3 miles southwest of Guntersville the Red Mountain formation lies on the west slope of the ridge and consists mainly of shale. A few seams of thoroughly leached ferruginous sandstone, 1 inch to 2½ inches thick are exposed in a ditch at the side of the road. The dip is 16° toward the southeast. Crusts of limonite were noted in the limestone area toward the northwest.

Sidney.—In the next township southwest of Guntersville and across the ridge from Sidney on the northwest slope of the ridge the following section was made by McCalley:

Partial section of Red Mountain formation northwest of Sidney in the NW¼ NW¼ sec. 12, T. 9 S., R. 2 E.
(M. I, pp. 350-351)

	Ft.
(11) Ferruginous soft sandstone in two prominent ledges separated by ferruginous limestone seam 14 to 16 inches thick	4
(10) Limestone, shaly, dull yellowish, ledge	4
(9) Shale, yellowish, with thin sandstone	20
(8) Limestone, roughly weathered, a dull ashy color though in places a little ferruginous, top of "middle" or "big seam"	5
(7) Shale	8
(6) Limestone, gray, with prominent sandy streaks, in places almost a sandstone on the weathered outcrops, bottom of "middle" or "big seam"	20
(5) Limestone, gray, hard	20
(4) Limestone, argillaceous, dull yellowish gray with reddish or ferruginous splotches, top of "calico rock"	7
(3) Shale, ferruginous	5
(2) Limestone; like (4) bottom of "calico rock"	7
(1) Limestone, a little argillaceous and ferruginous; in alternate layers with debris	5
"Trenton or Pelham" limestone, of a dull ashy blue color, with a growth of red cedar.	

As shown in this section there is nothing that could be regarded as an ore of iron. None was seen by the writer and an inquiry of residents in this locality failed to bring any reports of the presence of ore seams of any importance. About 3 miles north of Big Spring the Red Mountain formation is thin and unconformable on the Chickamauga limestone and shows no ore, but

Section of Red Mountain formation on the southeast side of Browns Valley about 1½ miles west of Fowler, Blount County, in the SE. corner sec 32, T. 9 S., R. 2 E.
(M. I, p. 377)

	Ft.	In.
Devonian, black shale		
(16) Shale, yellowish	20	
(15) Limestone, about	50	
(14) Ferruginous sandstone ledge	3	
(13) Limestone, flaggy, yellowish	30	
(12) Ferruginous limestone, in places quite and in other places not at all ferruginous		6
(11) Debris, doubtless covering shale	2	
(10) Ferruginous limestone; like (12)		4
(9) Debris, doubtless covering shale	2	
(8) Limestone, more ferruginous than (10) and (12)		6
(7) Debris, doubtless covering shale	4	
(6) Ferruginous limestone		8
(5) Debris, doubtless covering shale	1	
(4) Ferruginous limestone		8
(3) Limestone, ashy gray	20	
(2) Shale, sandstone; yellowish	35	
(1) Limestone, shale, about	90	
Pelham or Trenton limestone		

Approximate total thickness of formation, 260 ft.

Head of Browns Valley.—A road from Brooksville to Summit around the head of Browns Valley is mainly over Red Mountain formation, which consists mostly of beds of shale and thin sandstone lying nearly flat. No traces of iron ore were observed on this road.

Section of Red Mountain formation at head of Browns Valley, in Blount County, in the SE¼ sec. 14, T. 10 S., R. 1 E.
(M. I, p. 379)

	Ft.	In.
(9) Debris		
(8) Ferruginous sand; visible	1	
(7) Shale, yellowish	3	
(6) Ferruginous sand	4	
(5) Shale, yellowish	1	6
(4) Ferruginous sand		6
(3) Shale, yellowish	1	0
(2) Ferruginous sand	1	2
(1) Shale, yellowish		

Northwest border of Browns Valley

On the northwest side of Browns Valley, as has been stated before, the outcrop of the Red Mountain formation is badly broken and cut out for long distances by faulting; in fact it does not appear at the surface anywhere between the State line and a point about 2¼ miles northeast of Scottsboro.

Drilling near Stevenson.—Data obtained from drill holes is of interest here if the drill penetrates rocks of the Red Mountain formation. In 1912-1914 a hole was drilled for oil in McMahon Cove about 2¾ miles north of Stevenson and 1½ miles northwest of the Nashville, Chattanooga & St. Louis Railroad. The total depth of the drill hole is reported to have been 3180 feet. It started near the base of the Bangor limestone. According to the verbal report of the driller, 70 feet of black shale (Devonian) were passed through at depths of 475 feet; 32 feet of pink limestone (631 to 663 ft.); and 90 feet of very red limestone containing a seam of iron oxide or paint rock somewhere within (663 to 753 ft.). At about 670 feet a pocket of gas was encountered. Below the red limestone there was mainly limestone, and below that there was dolomite with chert to the bottom of the hole. At 1190 feet, a sandstone 20 ft. thick was reported to contain salt water. No oil was found and the exact records and samples from the hole are reported to have been lost, but it appears probable that a thin bed of ferruginous material underlies this locality. The Red Mountain rocks are cut out by faulting along the northwest border of the valley all the way from the State line to the vicinity of Scottsboro.

The rocks of the Red Mountain formation, where exposed on the northwest side of Browns Valley, are tilted steeply toward the northwest, or overturned in places so that they dip toward the southeast, and the ferruginous beds are not identical with and can not be correlated satisfactorily with the beds on the opposite side of the valley only 4 or 5 miles distant. This contrast is similar to that between the beds of red ore on the southeast and northwest borders of the Birmingham Valley.[1]

[1]Burchard, E. F., and Butts, Charles; Iron ores, fuels, and fluxes of the Birmingham district, Ala.: U. S. Geol. Survey Bull. 400, p. 40, 1910.

Columbus City to Summit.—A few sections by McCalley will serve to show the character of certain of the outcrops of the Red Mountain formation on the northwest side of Browns Valley, from northeast of Columbus City to Summit Mountain at the southwest terminus of Browns Valley:

Section of Red Mountain formation near Gunters old landing, Marshall County, in the northeast corner of sec. 27, T. 6 S., R. 4 E.
(M. I, pp. 354-355)

	Ft.	In.
Devonian, black shale		
(16) Sandstone, in blocks, dark bluish gray, most probably Devonian		2
(15) Shale, clayey, greenish		4
(14) Debris	1	2
(13) Limestone, shaly, argillaceous, dull ashy gray with irregular reddish and greenish streaks and splotches, interstratified with shale	4	
(12) Shale, greenish	3	
(11) Limestone, shale, slabby, bluish green interstratified with thin sheets of greenish shale	4	
(10) Debris	30	
(9) Limestone, argillaceous and shaly, of a dark greenish tinge	15	
(8) Shale, argillaceous, dull greenish gray	50	
(7) Debris, about	30	
(6) Shale, argillaceous, yellowish or straw color with black splotches between laminae	20	
(5) Debris, about	150	
(4) Limestone, argillaceous, greenish gray, alternating with debris	5	
(3) Debris	6	
(2) Limestone, argillaceous, dull greenish gray with reddish or ferruginous streaks, the "calico rock"	5	
(1) Limestone, argillaceous, dull greenish gray streaks interstratified with hard blue streaks, *Trenton or Pelham limestone*	30	

Partial section of Red Mountain formation about 3 miles north of Guntersville, in the SW¼ SE¼ sec. 22, T. 7 S., R. 3 E.
(M. I, p. 353)

	Ft.
(4) Shale, ferruginous sand	15
(3) Shale, yellowish	14
(2) Ferruginous sand, loose	5
(1) Shale, yellowish	

Partial section of Red Mountain formation southwest of Guntersville, in the NW¼ sec. 16, T. 9 S., R. 2 E.
(M. I, p. 352)

	Ft.	In.
(4) Shale, yellowish	10	
(3) Ferruginous sand, with thin clayey streaks near top	15	
(2) Shale, yellowish	1	6
(1) Ferruginous sand	4	

Only one analysis is cited by McCalley of ferruginous material from the northwest strip of the Red Mountain formation in Browns Valley. An average sample from a bed of loose black ferruginous sand about 25 feet thick in the SW¼ NW¼ sec. 25, T. 8 S., R. 2 E., about 6 miles southwest of Guntersville, showed 8.47 per cent metallic iron and nearly 71 per cent of silica (p. 314, analysis 9).

Section of Red Mountain formation on the northwest side of Browns Valley, on southeast side of "Tower or Summit Mountain" in Blount County, the SE¼ SE¼ sec. 36, T. 9 S., R. 1 E.
(M. I, p. 378)

	Ft.
Devonian, black shale	
(12) Shale, sandstone, iron ore; shale is yellowish and ferruginous, sandstone is flaggy, and iron ore is scaly and in thin streaks in the shale	15
(11) Shale, iron ore; ore is specular-like, though on weathering it becomes scaly; occurs in thin streaks in shale	10
(10) Limestone, slabby	25
(9) Ferruginous limestone, gnarly, very slightly ferruginous in most strata	20
(8) Limestone, sandstone; limestone is flaggy and changes gradually into the underlying slabby and flaggy sandstone, about	50
(7) Limestone, gray	12
(6) Ferruginous limestone, very slightly ferruginous	6
(5) Limestone, debris	35
(4) Ferruginous limestone; visible	1
(3) Limestone, debris	10
(2) Ferruginous limestone; like (6)	3
(1) Limestone, gray	45
Pelham or Trenton limestones	
Approximate total thickness of formation, 232 ft.	

A few observations were made in the course of the present survey at various places along the northwest strip of Red Mountain formation in Browns Valley but nowhere was it possible to find any red iron ore. Southwest of Scottsboro deposits of red iron loam containing a little rounded gravel obscure the underlying rocks in places. These loams and gravels strongly resemble deposits of the Coastal Plain that are common farther south and west but they probably represent deposits that have been distributed by Tennessee River. Northeast of Columbus City, the Red Mountain formation is in a vertical attitude and has probably been partly cut out by a fault. There is a little ferruginous sandstone present, but no iron ore.

The strip of Red Mountain formation from Warrenton northeast to Tennessee River shows only as yellow and red clay, and 1 mile south of Warrenton yellow shale dipping steeply toward the northwest shows in the road. A strip of Red Mountain formation is shown on the geologic map of the Gadsden quadrangle 1 mile north of Diamond. The rock consists of contorted yellow to red shale and clay dipping steeply northwest and is evidently partly buried in a fault. Some fragments of dark reddish ferruginous sandstone and limonite were strewn about the surface but no red ore was seen. Southwest of Red Hill a hook-shaped area of Red Mountain formation is indicated on the geologic map of the Gadsden quadrangle. The formation here consists of yellow to red clay with fragments of sandstone, but debris of Fort Payne chert from the neighboring hill obscures nearly all else. Exposures are poor toward the southwest. East of Summit only yellowish to purplish shale marks the area of Red Mountain formation. Between Summit and Brooksville there are good exposures of the Red Mountain shale and thin sandstone and the overlying Chattanooga shale. The beds are nearly horizontal and crop out continuously around the head of Browns Valley as indicated on the available geologic maps but no traces of iron ore are visible.

The following table summarizes the available analyses published by McCalley of the most ferruginous beds of the Red Mountain formation that crop out along Browns Valley. The first 8 analyses are of material from the southeast strip of the formation and the ninth is from the northwest strip about 6 miles southwest of Guntersville.

Analyses of the most ferruginous beds in the Red Mountain formation outcropping in Browns Valley, Ala.

	Locality	Authority-a	Fe	SiO_2	CaO	P
1	N½ NE¼ sec. 2, T. 1 S., R. 9 E	M-I, 284	19.67	4.76	34.05	.447
2	NE¼ SE¼ sec. 19, T. 5 S., R. 6 E	M-I, 300	9.39	5.15	37.04	.335
3	NE. cor. SE¼ NE¼ sec. 20, T. 6 S., R. 5 E.	M-I, 338	13.25	16.62	28.41	.296
4	NE. cor. NW¼ SE¼ sec. 30, T. 6 S., R. 5 E.	M-I, 340	11.65	26.01	31.34	.232
5	NW¼ SE¼ sec. 2, T. 7 S., R. 4 E	M-I, 343	12.69	28.09	25.50	.200
6	SW¼ NE¼ sec. 15, T. 7 S., R. 4 E	M-I, 344	16.93	16.34	29.47	.372
7	South of Tennessee River on northwest	M-I, 349	11.72	27.56	26.01	.479
8	side of ridge from Guntersville	M-I, 349	22.75	51.91	....	.684
9	SW¼ NW¼ sec. 25 T. 8 S., R. 2 E	M-I, 353	8.47	70.79	....	.396

a—McCalley, Henry, Report on the valley regions of Alabama, Part I, The Tennessee Valley Region: Alabama Geol. Sur., 1896.

The following table summarizes six analyses of ferruginous beds on the southeast side of Browns Valley made by Dr. R. S. Hodges, of the Geological Survey of Alabama and two by the U. S. Bureau of Mines.

Two additional analyses are given of specimens of slightly ferruginous limestone from Browns Valley tested in the laboratories of Emerson B. Poste at Chattanooga, Tenn.

Analyses of ferruginous beds in Red Mountain formation, southeast side Browns Valley

No. Sample	Locality and description of sample	Fe	Insol.	CaO	Remarks
R-16	West bank, Tennessee River about ½ mile north of Coffeys Ferry, in Sec. 23, T. 3 S., R. 7 E. Ferruginous, siliceous limestone,	3.64	4.31	49.03	Cf. Analysis 16-B, page
R-1 Upper	Ferruginous, fossiliferous limestone from top of hill at site of Williams' house, west side Tennessee River below south end of Buck Island. Red Mountain formation about 100 feet above base.	10.54	6.07	42.42	Cf. Analysis 7-B, page
R-1 Lower	Ferruginous limestone from lower part of Red Mountain formation west side Tennessee River below south end of Buck Island.	1.41	11.92	46.67	
R-2	Soft, siliceous "ore" from 7-foot bed in northwest part of Guntersville	22.29	59.26	0.41	Cf. Analysis 2-B, page
R-4	Ferruginous, sandy limestone from prospect slope southwest of Guntersville in SW¼ sec. 10, T. 8 S., R. 3 E	7.50	21.91	34.90	Cf. Analysis 4-A, page
24583	Slightly ferruginous limestone from Tennessee River near Stevenson	1.66	8.57	46.97	
24592	Slightly ferruginous limestone from Tennessee River near Bridgeport	2.51	7.35	48.66	
R-5	Massive ferruginous bed sectioned ½ mile above mouth of Widow Creek, page 294.	14.33	46.00	15.27	Insoluble is Silica. Phosphorus, 1.35%

The absence of iron ore from the Red Mountain formation in Browns Valley has been shown in the preceding sections. In his description of the geology at the head of Browns Valley McCalley[1] states that the full thickness of the Red Mountain formation, 225 to 275 feet, can be seen in many places on both sides of the valley. The shale, limestone, and sandstone strata are ferruginous in places, "though not enough so to be valuable as iron ores," and the weathered outcrops are nothing more than ferruginous sandstone and loose ferruginous sand that doubtless represent weathered ferruginous limestone. He notes that the strata on the northwest side of the valley dip more steeply and are weathered and broken to a greater extent than on the southeast side of the valley and also that the strata on one side of the valley differ in certain

[1]McCalley, Henry, Op. cit., p. 376.

particulars from those on the opposite side. McCalley ascribes these variations to differences in weathering rather than to differences in original deposition, which seems to be the more likely explanation.

It may at first appear that a great deal of fruitless work has been done in following out the exposures of Red Mountain formation in Browns Valley and the earlier records thereon in this present study only to arrive at negative conclusions concerning the possibility of finding iron ore in the area. In justification of this course it should be stated that geological investigations are carried on primarily to get facts, whether they be favorable or unfavorable to the occurrence of mineral resources. If the facts show, as they do in this instance, that the beds of low-grade iron ore that are present on the borders of the Lookout Mountain syncline deteriorate and disappear toward the northwest some ineffectual prospecting and much hopeless investment of money in alleged "iron ore land" may be saved. The writers maintain that prevention of unwise investment is an important function of work in economic geology as well as the indication of promising fields for development.

INVESTIGATIONS BY TENNESSEE VALLEY AUTHORITY

A practical demonstration of the significance of geological fact finding was made by the geologists of the Tennessee Valley authority prior to the flooding of the Guntersville Reservoir. This reservoir extends up the Tennessee River from the Guntersville Dam, northwest of Guntersville, Marshall County, Alabama, to the Hales Bar Dam near Jasper, Marion County, Tennessee, a distance of about 80 miles.

Prior to the flooding of the Guntersville Reservoir it was deemed advisable by the officials of the Tennessee Valley Authority to ascertain what valuable minerals might be present on or below the surface or along the borders of the area to be flooded. The detailed study was carried on by geologists and engineers of the Authority and certain consulting geologists in cooperation with the United States Geological Survey and the Geological Survey of Alabama. Most of the field work with reference to iron ore was done in late 1938 and early 1939, so that the data gathered are generally more recent than those acquired directly in the preparation of this Special Report, and it is most fortunate that they have been made available for presentation herewith.

The geologic work of the Tennessee Valley Authority comprised the measurement of a number of detailed geologic sections of the Red Mountain formation within the reservoir area and at these places samples of material were gathered for paleontological studies and chemical analyses. Drilling was done in order to obtain a complete section of the formation within a small area because many of the surface exposures were partly obscured by debris. (See Fig. 15). As in the work of the Federal and State geological surveys little or no ferruginous material worthy of the name of iron ore was found and where the percentage of iron was of interest the thickness and extent of the beds were too small to warrant commercial development. Sixteen of the geologic sections in the Alabama part of the reservoir and chemical analyses of the ferruginous beds are given on pages 325-333 of this report.

The geologic sections were prepared by Robert M. Ross and Cecil B. McGavock, geologists of the Water Control Planning Department of the Tennessee Valley Authority. Paleontological studies led Mr. Ross to decide that the upper, or "Clinton," part

of the Silurian Red Mountain formation, which is the important iron-ore bearing part of the formation in the Birmingham District is not present in the Guntersville Reservoir area. Some of the lower part of the Silurian system, consisting of beds of Richmond age below, and of Medina (Brassfield) age above is present in the Guntersville Reservoir area, but happens not to be rich in iron in this area nor has iron ore been found in its outcrops farther west in Alabama. According to determinations by other geologists certain beds of red iron ore in Greasy Cove and Shinbone Ridge, which lie farther east in Alabama, and the iron ore at Rockwood, Tennessee, are of Brassfield age, to which also the Irondale iron ore "seam" of the northeastern part of the Birmingham District has been assigned.[1]

It may be that the iron ore beds of Brassfield age in Greasy Cove and Shinbone Ridge are higher in the stratigraphic section than the beds in the Guntersville Reservoir. They may never have been deposited in the latter area, or if they were once present they may have been removed by erosion in pre-Mississippian time. The discovery by Ross that the true "Clinton" iron-bearing beds of the Birmingham area are not present in the flooded area will have an important bearing upon the valuation of the land if any such question should arise in the future.

The following heretofore unpublished paper is, therefore, quoted herewith by permission of the Tennessee Valley Authority and of Mr. Robert M. Ross, the author.

[1]Personal communications from E. O. Ulrich and Charles Butts of the U. S. Geological Survey.

PALEONTOLOGIC CORRELATION OF THE MEMBERS OF RED MOUNTAIN FORMATION IN THE GUNTERSVILLE RESERVOIR

Robert M. Ross

INTRODUCTION

Preliminary studies of the Red Mountain formation in the region of the Guntersville Reservoir convinced the writer that only the lower members (Richmond and Brassfield) were present. No evidence of the overlying Clinton member, which composes the bulk of the formation at Birmingham, could be discovered. The numerous mineral damage claims, based on the alleged presence of workable iron ore in the Red Mountain formation, to which the Tennessee Valley Authority is subject, gave particular significance to the apparent absence of the Clinton. At Birmingham, three of the four beds of ore which are present—including the Big Seam, which is the only one now being worked—are in the Clinton. The contention that valuable ore exists in the Guntersville Reservoir rests, in a large measure, on the assumption that the ore-bearing strata at Birmingham continue north beneath Sand Mountain and reappear in the Sequatchie Valley. Accordingly, if the absence of the Clinton here were conclusively established, this argument would be completely invalidated.

Under these circumstances, it was felt that a careful paleontologic study with a view to making definite, well-founded correlations of the members of the Red Mountain formation in the Guntersville Reservoir would be well worth while. This investigation was made by the writer during the latter part of April 1939, and is the subject of the present report.

Lithology of the Red Mountain Formation

The formation is lithologically divisible into two easily-distinquished members in the Sequatchie Valley. The lower is ordinarily composed of red, crystalline, massively bedded, often sandy limestone and soft, fissile, greenish-gray, calcareous shale. The limestone is ferruginous and fresh samples sometimes contain as much as 11 percent iron. Where the rock is weathered and the carbonates have been removed by leaching, the percentage of iron rises considerably, of course. In some localities, as in the vicinity of Buck Island, the lower member is almost entirely limestone, while in north Guntersville, near Haney Chapel, and at certain other places, the greenish shale predominates.

At the top of the member is a light gray, hard, calcareous sandstone from two to six feet thick. It is ordinarily fine grained but occasionally becomes coarse. When leached it becomes porous and assumes a brown color, and this is its usual appearance in natural outcrops. The bed is of widespread occurrence, stands out prominently in outcrops, and serves as an excellent key bed when stratigraphic work is being done on the Red Mountain. It was found in thirteen of eighteen sections measured in the reservoir area and was very likely represented in some of the remaining five, since the exposures in several were broken by large covered intervals. This sandstone and the red, ferruginous limestone are the distinguishing features of the lower member. The limestone is typical of the Richmond in Alabama and Tennessee. The lower member varies from about 30 to 70 feet in thickness.

The upper member consists mainly of soft, fissile, greenish-gray calcareous shale. Throughout a considerable portion, however, the lime content is high enough to produce a gray, thin-bedded, slabby, siliceous limestone. At most points there is a thin, red streak of ferruginous material in the upper half of the member. Reddish tints may sometimes be found through a ten-foot thickness of rock, although seams bearing appreciable percentages of iron are never more than five or six inches thick, in the reservoir area. Just to the north, at Inman, Tennessee, the seam increases to a five-foot ore bed which was, at one time, extensively worked. The thin ferruginous seam, like the sandstone bed at the top of the lower member, is very useful as a horizon marker. It appeared in ten of the eighteen measured sections,

its horizon was covered in six, and it was definitely absent in only two. The thickness of the upper member is from about 100 to 140 feet.

The Red Mountain formation is underlain by the Chickamauga limestone. The top beds of the Chickamauga are sometimes of Trenton age and sometimes of Maysville. In either case they are of gray or bluish-gray, thin bedded limestone which is usually distinguished from the basal red, massive limestone of the Red Mountain without difficulty. Overlying the Red Mountain is the black, hard, fissile Chattanooga shale which is quite distinct from anything below it.

During the winter of 1938-39, very detailed stratigraphic investigations were made by Mr. C. S. Blair, Consulting Geologist, C. B. McGavock, Jr. Junior Geologist, and the writer. Eighteen sections of the Red Mountain, including every large exposure which could be found in the reservoir, were examined and measured. Most of these sections are appended under Summary and Conclusions, pp. 324-333. (Figs. 14, 15.)

Paleontologic Correlation

Nearly all the fossils studied were collected from the Bridgeport Ferry Section, about two miles southeast of Bridgeport, on the road to the ferry. The Red Mountain is very much more fossiliferous here than at any other known locality near the reservoir. The section is also very favorable for use in correlation in that nearly all the formation, as well as its contacts with the underlying Chickamauga limestone and the overlying Chattanooga black shale, is exposed, and the sandstone bed in the lower member and the ferruginous seam in the upper are present. Fossils were collected from three zones. The first was in a limestone bed about the middle of the lower member, the second was in the limestone immediately below the sandstone stratum which lies at the top of the lower member, and the third extended through the shale-streaked limestone of the upper member. The section follows:

Bridgeport Ferry Section

	Thickness (feet)
Chattanooga black shale	
Red Mountain formation	
Shaly, siliceous limestone. Somewhat fossiliferous (Zone 3)	30
Reddish, ferruginous limestone	0.5
Thin-bedded, siliceous, somewhat fossiliferous limestone. Streaked with greenish-gray shale and contains a little chert. (Zone 3)	45
Greenish-gray, soft, fissile shale	30
Brown, fine-grained, porous sandstone	2
Gray or reddish, coarsely crystalline, thick-bedded limestone. Abundantly fossiliferous in some places. (Zone 2)	10
Fissile shale, weathering greenish or yellowish	15
Reddish, coarsely crystalline, thick-bedded limestone. (Zone 1)	4
Greenish-gray shale, siliceous limestone, and brown, porous sandstone interbedded	20
Sandy shale, weathering greenish and yellowish	10
Chickamauga limestone	

The following fossils were found in Zone 1:

Coral—

Streptelasma rusticum Billings

Brachiopods—

Rafinesquina alternata ponderosa Ulrich
Rhipidomella sp. (?)

Streptelasma rusticum is an index fossil of the Richmond formation. *Rafinesquina alternata ponderosa* is typical of the Maysville; it may be that a few of the species persisted on into the overlying beds or, perhaps, the Bridgeport specimen was a very large example of *Rafinesquina alternata*, which is a common Richmond fossil. A specific identification of *Rhipidomella* was impossible as only one very poor fragment of a specimen was found. Several species occur in the Richmond.

Zone 2 produced the following fauna:

Coral—
Streptelasma sp.

Brachiopods—
Dalmanella meeki Miller
Dinorthis carleyi Hall
Leptaena richmondensis Foerste
Rhynchotrema capax Conrad
Hebertella sinuata Hall
Stropheodonta sp. (?)
Eridorthis cf. *rogersensis* Foerste

All these forms, with the exception of *Eridorthis rogersensis,* are characteristic of the Richmond. *Dalmanella meeki, Dinorthis carleyi, Leptaena richmondensis,* and *Rhynchotrema capax* are index fossils. *Eridorthis rogersensis* is an Eden fossil. It is possible that the species carried over into a later time or that the specimens from Bridgeport represent a slightly different form, although they occur abundantly and appear identical to *E. rogersensis.*

The fauna from Zone 3 follow:

Corals—
Favosites favosus Goldfuss
Streptelasma sp.

Brachiopods—
Hebertella fausta Foerste
Sowerbyella prolongatus Foerste
Leptaena rhomboidalis Wilckens
Dalmanella sp.
Whitfieldella sp.
Eridorthis cf. *rogersensis* Foerste

Favosites favosus is characteristic of the Brassfield formation, although it is not confined to it. The *Streptelasma* present appeared to be *S. hoskinsoni,* which is a Brassfield index fossil, but the available specimens were not good enough for a positive identification.

Hebertella fausta and *Sowerbyella prolongatus* are index fossils of the Brassfield, while *Leptaena rhomboidalis, Dalmanella,* and *Whitfieldella* are likewise characteristic of it.

Summary and Conclusions

Every fossil found in Zones 1 and 2, with a single exception, is known to occur in the Richmond formation, and five are index fossils. The lower member of the Red Mountain in the Guntersville Reservoir area is undoubtedly of Richmond age.

The fossils of Zone 3, also with one exception, are all typical of the Brassfield, two of them being index fossils. The upper member of the Red Mountain, therefore, represents the Brassfield formation.

The Clinton, which is the only important ore-bearing member at Birmingham, is not present. The correlation of a typical Red Mountain section (the Buck Island section), near Guntersville, with a composite section from Birmingham is shown on an appended drawing. (Fig. 14.) A profile of the Buck Island drilling illustrating the method by which the complete Buck Island section was obtained, is also appended. (Fig. 15) As a consequence of the Clinton's absence, no ore equivalent to the Birmingham ore (except the Irondale seam, which is not worked now) can exist in the vicinity of the Guntersville Reservoir.

Additional proof of the Clinton's absence is provided at Inman, Tennessee, where crinoid buttons with scalloped margins occur in the ore bed, only a few feet below the Chattanooga black shale. According to Ulrich these buttons, or stem plates, are confined to strata of Brassfield age.[1]

[1]Adams, Butts, Stephenson, and Cooke; Geology of Alabama, Special Report No. 14, 1926, p. 141.

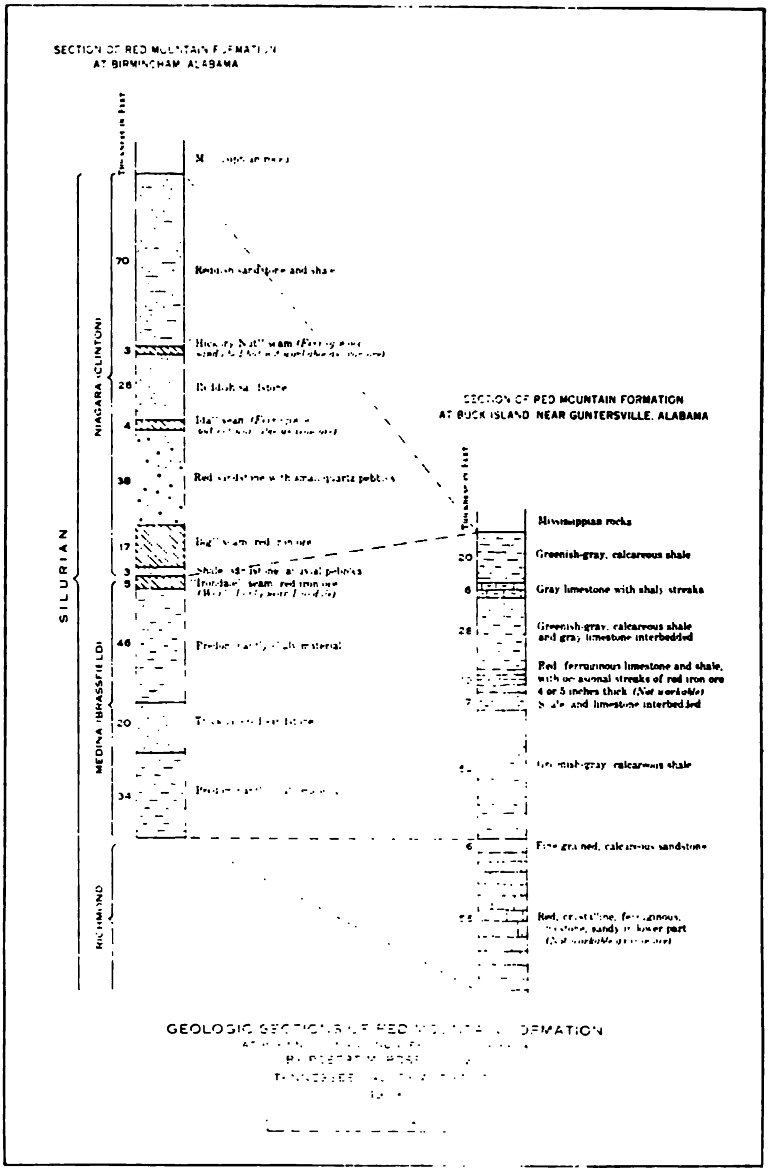

Fig. 14. Geologic sections of Red Mountain formation at Birmingham and Guntersville.

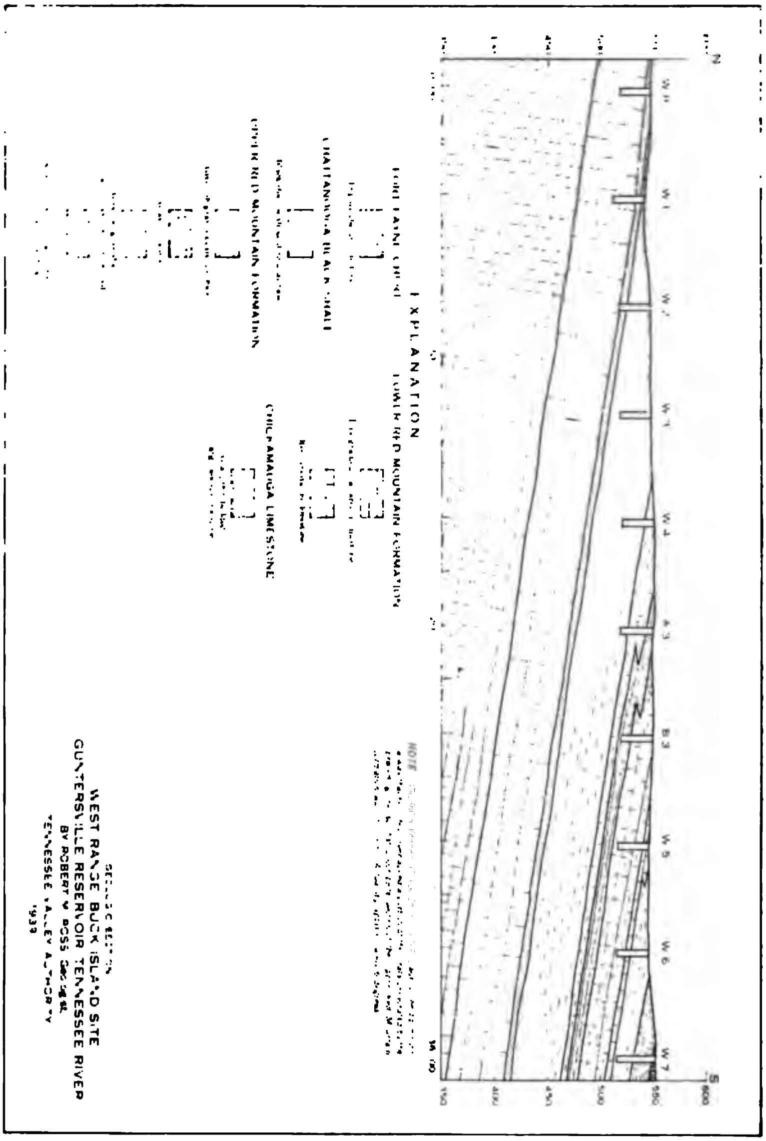

Fig. 15. Geologic section, west range, Buck Island site, Guntersville reservoir, Tennessee River.

Geologic Section

Bridgeport Ferry—S 20, *T* 1 *S*, *R* 9 *E*

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Limestone, slabby, siliceous, shaly, fossiliferous	30
Limestone, shaly, ferruginous	0.5
Limestone, slabby, siliceous, with shale and a little chert, fossiliferous	45
Shale, green	30
Sandstone, fine, brown, porous	2
Limestone, coarse crystalline, some is ferruginous; fossiliferous	10
Shale, greenish-yellow	15
Limestone, coarse crystalline, ferruginous, massive	4
Shale, siliceous limestone, brown, porous sandstone	20
Shale, greenish-yellow, sandy	10
Chickamauga Limestone	

Geologic Section

Coffee Ferry—S 23, *T* 3 *S*, *R* 7 *E*

	Ft.
Eroded and covered	
Red Mountain Formation	
Limestone, ferruginous, coarse crystalline, massive	20
Covered-short gap	
Sandstone, fine porous, brown thin bedded; Shale and brown shaly limestone	20
Chickamauga Limestone	

Geologic Section

Sublet Ferry Gap—S 18, *T* 4 *S*, *R* 7 *E*

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Shale, olive with a few thin limestone beds	50±
Limestone, sandy	1
Shale, greenish-yellow, well exposed	60-70
Limestone, sandy, crystalline, weathering to sandstone, coarse, porous, brown	25
Sandstone and Shale, fine, porous, brown	5
Chickamauga Limestone	

Geologic Section

McQuinns Ferry—S 26, T 4 S, R 7 E (?)

	Ft.
Covered	
Red Mountain Formation	
Shale, yellow and green	100
Sandstone, coarse, brown, porous, weathered, some is ferruginous	6
Shale, brown	2
Sandstone, fine, porous, brown	5
Chickamauga Limestone	

Geologic Section

E. Scottsboro Highway—S 34, T 4 S, R 6 E

	Ft.
Top covered	
Red Mountain Formation	
Shale, green with siliceous limestone beds in upper part	75
Shale, ferruginous clay	2½
Shale, green	3
Clay, ferruginous, porous	3
Shale, green with ferruginous sandstone beds	6
Shale, green	15
Sandstone, weathered, porous, coarse, derived from sandy limestone	20
Chickamauga Limestone	

Geologic Section

Near Roseberry Cr.—S 8, T 5 S, R 6 E

	Ft.
Top covered	
Red Mountain Formation	
Shale, green, occasional exposures	100±
Sandstone, weathered, porous, brown, coarse in top, fine in bottom, derived from Limestone	10-15
Chickamauga Limestone	

Geologic Section
Larkins Ferry—S 25, *T* 5 *S*, *R* 5 *E*

	Ft.
Covered	
Red Mountain Formation	
Shale, green, with thin limestone beds. Estimated	100
Base partly covered	
Limestone, ferruginous, crystalline, massive, variable thickness	6-20
Shale and Limestone	3
Chickamauga Limestone	

Geologic Section
Kirbytown Gap—S 20, *T* 6 *S*, *R* 5 *E*

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Shale, green	10
Limestone, shaly, with ferruginous streaks	2
Shale	15
Covered	100
Shale, green	30±
Limestone, slightly ferruginous, coarse crystalline, sandy	10
Limestone, banded gray and green, crystalline, sandy	10
Chickamauga Limestone	

Geologic Section
Haney Chapel Gap—S 11, *T* 7 *S*, *R* 4 *E*

	Ft.	In.
Covered		
Red Mountain Formation		
Limestone, ferruginous, shaly		11
Shale, green	60-70	
Limestone, porous, sandy, ferruginous, weathered	1	
Shale, green	1	
Limestone, porous, sandy, ferruginous, weathered	1	
Shale, green	4	
Limestone, soft, sandy, ferruginous, weathered	4	
Shale, green	20	
Covered		

Geologic Section

Haney Chapel 2—S 15, T 7 S, R 4 E

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Shale, mainly covered, limestone float, slabby, siliceous	70
Limestone, siliceous, slabby	3
Limestone, dense ferruginous	1
Shale and limestone	5
Limestone, ferruginous	1½
Shale, green, limestone, slabby	45
Sandstone, porous, brown	2
Limestone, medium grain, low ferruginous	4±
Shale, green, some limestone, slabby	45
Limestone, coarse crystalline, sandy	5
Chickamauga Limestone	

Geologic Section

Buck Island, E.—S 15, T 7 S, R 4 E

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Shale, greenish, mostly covered	50
Shale, green with thin bedded siliceous limestone	25
Limestone, ferruginous, siliceous	1½
Limestone, thin bedded, shaly, fossiliferous	10-15
Shale, greenish-gray	40-50
Sandstone, fine, brown, calcareous	3
Limestone, massive coarse crystalline, ferruginous	6
Covered	

Geologic Section

Buck Island, W.—S 19, T 7 S, R 4 E

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Shale, greenish-gray, calcareous	20
Limestone, gray with shale	6
Shale, greenish-gray, calcareous with interbedded limestone	30
Limestone, slabby and shale	5
Limestone, ferruginous, mottled	½
Limestone, slabby and shale	10
Shale, greenish-gray, calcareous	50
Sandstone, fine, brown, calcareous	6
Limestone, coarse crystalline, ferruginous, massive	20
Limestone, coarse crystalline, sandy, ferruginous	30
Limestone, gray, coarse, sandy	5
Chickamauga Limestone	

Geologic Section

Pendleton Hollow—S 30, T 7 S, R 4 E

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Shale, green, mostly covered	35-40
exposures	75±
Sandstone, brown, porous	2
Interval, covered	
Limestone, coarse crystalline pink, massive, gray and sandy at base	20±
Chickamauga Limestone	
Ferruginous bed, brown, porous, weathered, fossils	0.5
Shale, green and Limestone, slabby, scattered	

Geologic Section

Lusk Hollow—S 25, T 7 S, R 3 E

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Shale, covered	20-25
Limestone, thin bedded with shale streaks, fossils	20
1" - 2" limestone, ferruginous, irregular	
Limestone, thin bedded with shale	15-20
Shale, green	40
Sandstone, porous, brown	2
Shale, green	10-15
Limestone, massive bedded, dense, ferruginous, stained, with Limestone, light, sandy, crystalline at base	15-20
Covered	
Chickamauga Limestone	

Geologic Section

N. Guntersville—S 11, *T* 8 *S, R* 3 *E*

	Ft.
Covered	
Red Mountain Formation	
Shale, greenish-yellow	40
Sandstone, porous, brown	4
Limestone-shale partings, weathered, ferruginous	2
Shale, green	6
Limestone, porous, soft, sandy, ferruginous, weathered	7
Limestone, thin, shaly, fossiliferous	3
Shale, greenish	40
Limestone, coarse crystalline, sandy	8-10
Chickamauga Limestone	

Geologic Section

Carlisle—S 10, *T* 8 *S, R* 3 *E*

	Ft.
Chattanooga Shale	
Red Mountain Formation	
Shale, green	30
Limestone, shale, ferruginous	2
Shale, green, mostly covered	60
Sandstone, porous, brown, calcareous	5
Shale, Limestone, ferruginous	2
Shale, soft green	6
Limestone, ferruginous	3
Shale, green	6
Interval, mostly covered	35±
Chickamauga Limestone	

Analyses of ferruginous beds in Red Mountain formation in Guntersville Reservoir, reading from northeast to southwest. Analyses made by Tennessee Valley Authority

Sample No.	Locality and Description	Fe	Percent SiO_2	CaO	Remarks
21-A	Best material from 5-foot bed at top of lower Red Mountain (just below sandstone bed) near Jasper, Tenn.	7.92	3.92	45.74	
17-A	Bridgeport Ferry. Best material in lower Red Mountain formation, from bed just below sand stone bed.	1.67	5.12	49.22	
16-D	Coffey Ferry. Representative of highest limestone bed, 3 feet thick	4.13	3.62	48.56	
16-C	Coffey Ferry. Representative of next to highest limestone bed, 3 feet thick	2.45	1.96	51.60	
16-B	Coffey Ferry, Representative of next to lowest limestone bed, 3 feet thick	3.68	2.02	50.94	
16-A	North of Coffeys Ferry. Representative of lowest end of ferruginous limestone, 2 feet thick	4.58	1.60	50.20	
12-B	Scottsboro Highway. Channeled from bottom ferruginous bed 3 feet thick; very weathered material	27.01	31.16	trace	
12-A	Scottsboro Highway. Channeled from top ferruginous bed 2 feet thick; very weathered material	22.54	37.90	trace	
11-A	About 100 yds. S. of safety harbor at Larkins Ferry. Representative of ferruginous limestone 3 feet thick at top of bluff	8.26	2.14	47.42	
10-A	Kirbytown Quarry. Representative of top 4 feet, weathered portion of red bed at top of quarry	10.41	79.52	0.62	
8-B	Haney's Chapel Gap. Best "ores" from lower bed	25.89	51.84	1.44	
8-A	Haney's Chapel Gap. Channeled representative of lower 3-foot bed; very much weathered	22.54	43.84	3.14	
7-B	East of Buck Island. Upper "ore" streak, 4 inches thick. from Brassfield strata	10.97	18.32	25.64	
7-A	East of Buck Island. Representative of more than 4 feet vertical extent ferruginous limestone just below sandstone	10.15	4.68	43.34	
1-A	Near house on Williams place at Buck Id. From 2-foot ferruginous stratum at top of knob	12.04	6.44	39.00	
1-B	Buck Island. Representative of more than 20 feet vertical extent, non-sandy ferruginous limestone just below sandstone	3.24	3.20	51.48	
1-C	Buck Island. Representative of 30 feet vertical extent of sandy, ferruginous limestone just below that from which sample 1-B came. Bed is almost at base of Red Mountain formation.	3.68	44.50	27.62	
2-A	Safety Harbor. N. Guntersville. Weathered "ore" just beneath sandstone stratum.	8.93	69.22	trace	
2-B	North Guntersville. Channeled from 7-foot "ore" bed about 6 feet below bed from which sample 2-A came.	21.65	52.86	0.42	
4-A	Glover mine. Carlisle place. Representative of entire vertical extent of 3-foot ferruginous bed.	6.70	20.62	36.45	
4-B	Glover mine. Carlisle place. Best, unweathered "ore"; taken from dump of slope	11.05	4.94	42.74	

PLATEAU COUNTIES

General Statement

In connection with the study of the iron ore of the Red Mountain formation in northeast Alabama the problem of the occurrence of ore below the plateau country is of interest and importance from both commercial and scientific viewpoints. Relatively little has, however, been ascertained along this line. The avenues of approach to the question are (1) comparative studies of the outcrops of the ore-bearing formation from southeast to northwest, and (2) studies of the records of drill holes that penetrate the Red Mountain formation.

The character of the outcrops of the Red Mountain formation from southeast to northwest is indicated in the descriptive data given in preceding chapters. The several outcropping strips of the formation are shown in Plate 1, but in this illustration the ore is classified only as to thickness. In a broad generalization as to the physical character of the ore-bearing formation it might be stated that beginning with the Lookout Mountain synclinal axis the ore beds and their inclosing rocks tend to become more siliceous toward the southeast and more calcareous toward the northwest. The Red Mountain formation, it has been shown, does not extend far toward the southeast, the Beaver Creek-Greens Creek-Colvin Mountain ridge on the northwest border of the Coosa coal field constituting the southeastern limit of the formation as at present mapped. Toward the northwest the Red Mountain formation has been recognized as far as the northern border of Alabama in Lauderdale and Madison counties and therefore it is fair to presume that it underlies the plateaus between the areas of outcrop. This assumption can not, however, be extended to the beds of ore themselves, for northwestward from Lookout Mountain the outcropping ore is found to progressively deteriorate. For instance, in Wills Valley the Red Mountain, or southeast strip of outcrop, contains good iron ore in many places, but on the northwest side of the valley it is not so good, and in Browns Valley, 20 to 25 miles toward the northwest, there is little but ferruginous limestone present, and in the outcrops in Lauderdale County the formation is thin and entirely of limestone without containing any

markedly ferruginous beds. Butts[1] states that the Red Mountain formation, except the ore-bearing Clinton part, underlies Tennessee River Valley.

Unfortunately for the present study few holes have been drilled solely to gain information concerning iron ore. For the areas of most importance in the present study, viz., Lookout, Sand, and Blount Mountains, there are almost no definite, or well authenticated, drill records. These areas are of greater importance from the standpoint of ore occurrence than the areas farther west because they are bordered by the Red Mountain formation and theoretically constitute extensive basins which might hold reserves of ore for future exploitation, through local but unknown thickening of the ore beds, although the known outcrops of the beds themselves do not indicate attractive thicknesses or quality of hard ore. Most of the deep drilling that has been done in northern Alabama has been for the purpose of exploring for petroleum and such drilling would naturally be done in areas of anticlinal structure rather than in basins, and also since the Paleozoic rocks in which it was hoped to find petroleum are principally of Mississippian and Pennsylvanian age comparatively few holes were drilled as deep as the Silurian rocks.

Drill records

Fortunately for the present study a large number of records of wells drilled for oil, from which may be selected those few which penetrate the Silurian strata, have been made available in publications by Doctor Semmes[2] and others and to these reports the reader is referred for more complete details. Notes on these drillings, together with others that are available, will be given by counties beginning at the north. Drillings have been made in many other counties but as they did not reach strata of Silurian age they are not of present interest and are therefore not mentioned herein. In the following notes by counties it will be necessary to give only data concerning the Silurian strata encountered. The classifications and correlations are as given in Special Report 15.

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[1]Butts, Charles, Geology of Alabama: Geol. Survey of Alabama, Special Rept. 14, 1926, p. 134.

[2]Semmes, Douglas R., Oil and gas in Alabama: Geol. Survey of Alabama, Special Rept. 15, 1929. See also Bowles, Edgar, Well Logs of Alabama; Geological Survey of Alabama, Bull. 50, 1941, and Toulmin, Lyman D., Well Logs of Alabama, 1940-1945: Geological Survey of Alabama, Bull. 57, 1945.

Lauderdale County

A well drilled in 1930 about 1 mile east of Gravelly Springs (1) encountered hematite at two horizons according to the drill log in the files of the Geological Survey of Alabama.

Silurian strata in well (1) Lauderdale County about 1 mile west of Gravelly Springs Sec. 8 T. 2 S., R. 13 W.

Well begun in Mississippian	Mississippian rocks	
	Chattanooga shale	164-168
Silurian	Lime, sandy	182
	Lime, light gray	202
	Shale, green, sandy	232
	Lime	307
	Chert and lime	340
	Hematite	346
	Lime, hard	350
	Hematite	426
	Lime, white	438
	Slate, sandy; lime	508
	Slate, sandy; hard limestone	514
	Slate, sandy; lime	526
	Bottom of well in August, 1941 in Cambrian or Ordovician limestone	2525

No details as to the thickness of the seams of hematite were available nor were there any samples of the drill cuttings.

In August, 1941, a well being drilled about 5 miles east of Gravelly Springs (2) was in Ordovician rocks at 1200 feet. Silurian strata are indicated by the presence of pink and red limestone, some of it glauconitic.

Silurian strata in well (2) Lauderdale County about 5 miles east of Gravelly Springs SW¼ NE¼ NW¼ sec. 8, T. 2 S., R. 12 W.

		Thickness Feet	Depth Feet
Well started in Fort Payne chert			
Top of Silurian			195
Mississippian	Chattanooga shale	18	195
Silurian	Limestone, gray; brown, glauconitic lime; quartzitic sandstone	20	215
	Lime, light green; shaly lime; light gray limestone with pyrite; shale	70	285
	Same with pink and reddish tinged limestone; red limestone; green limestone	80	365
	Limestone, green, gray, pink, red, fossiliferous; some glauconitic	35	400
	Limestone, gray and black; phosphatic lime	10	410
Bottom of well in August, 1941, in Ordovician limestone at 1200 ft.			

For Lauderdale County the sections of four wells are given by Toulmin.[1] The presence of red rock was noted in all four of these drillings, thus corroborating the finding of ferruginous beds in the two holes recorded in this report.

[1]Toulmin, L. D., Op. cit., pp. 88-91.

Limestone County

A well drilled about 5 miles north-northeast of Athens (1) in 1941 is shown to pass through Silurian strata by the drill log in the files of the Geological Survey of Alabama.

Silurian strata in well (1) Limestone County about 5 miles north-northeast of Athens NW¼ NE¼ NW¼ sec. 15, T. 2 S., R. 4 W.

		Thickness Feet	Depth Feet
Well started in Maury green shale			
Top of Silurian			70
Silurian	Shale, gray; pink and gray lime, pink crinoid stems; pyrite; green shale with black nodules	5	75
	Shale, gray, with pyrite; black concretionary material; pink limestone fragments; pink crinoid stems	5	80
	Shale, dark greenish gray, calcareous; light gray fossiliferous crystalline limestone with pyrite specks; dark gray shale with black nodules	5	85
	Limestone, black and gray, with black concretions; brown, finely crystalline limestone	10	95
	Lime, greenish gray; shaly lime	5	100
	Limestone, gray and black, with small black inclusions	5	105
	Limestone, light gray crystalline; light green limestone; dull reddish brown limestone with pyrite; dark gray shale	10	115
	Limestone, light green and light gray; slightly reddish brown limestone	10	125
	Limestone, light gray crystalline; dark gray to black crystalline limestone with small black inclusions	5	130
	Bottom of well in Ordovician limestone		445

The record of a well drilled in Limestone County in 1941 did not indicate any ferruginous beds in Silurian strata.

Silurian strata in well (2) Limestone County about 4 miles east of Athens (2) Center of NW¼ NW¼ SW¼ Sec. 7; (?) T. 3 S., R. 3 W.

		Thickness Feet	Depth Feet
Well started in the Fort Payne chert			
Top of Silurian			110
Silurian	Limestone, green and gray; pink-tinged limestone	5	115
	Limestone, gray and pink crystalline; with pyrite; dark gray fossiliferous limestone with black phosphatic inclusions	30	145
	Limestone, gray and greenish; with pink-tinged limestone	10	155
	Bottom of well in Ordovician limestone		331½

Madison County

A well was drilled sometime after 1928 about 1.5 mile east-northeast of Fisk (1) in Madison County. According to the log of the well given below no ore was encountered in the well. The log is given as it appears on the records of the Alabama Geological Survey, and includes the rocks from the Chattanooga shale through the horizon of the Pencil Cave beds, since the latter is known to be in the Ordovician.

Silurian strata in well (1) Madison County about 1.5 mile east northeast of Fish NW¼ NW¼ SE¼ sec. 8, T. 1 S., R. 1 E.

Well started in maury green shale

	Character of Material	Thickness Feet	Depth Feet
Mississippian	Chattanooga shale	6	9.5
Silurian	Sandstone	.5	10
	Limestone, gray	20	30
	Lime, gray and pink	15	45
	Lime, light pink	20	65
	Sand, pink fresh water	5	70
	Lime, pink mixed with a little darker limestone	5	75
	Limestone, blue, shaly	10	85
	Limestone, black, gritty	5	90
	Limestone, dark, shaly	5	95
	Limestone, blue, shaly	10	105
	Limestone, dark gray, shaly	5	110
	Limestone, gray and red	20	130
	Limestone, light gray	25	155
	Limestone, dark gray	5	160
	Limestone, black mixed with light granular	5	165
	Limestone, gray sandy	5	170
	Limestone, light-gray and dark mixed	40	210
	Limestone, very dark	5	215
	Limestone, blue and gray	15	230
	Limestone, drab or dove	10	240
	Limestone, blue	15	255
	Limestone, dark and brown	10	265
	Limestone, gray	5	270
	Limestone, dark and brown	25	295
	Limestone, gray and brown mixed	5	300
	Limestone, brown	15	315
	Limestone, black with white specks	5	320
	Limestone, brown	10	330
Ordovician	Limestone, dark-gray	5	335
	Limestone, dark shaly	5	340
	Limestone, dark shaly, gritty, (Pencil Cave beds)	5	345
	Bottom of well in Ordovician (?) sandstone		12+5

A well drilled in 1890 at New Market, Madison County, (2) went deep enough to have penetrated the Silurian but the record, which follows, shows no ferruginous material:

Silurian and Ordovician strata in well (2) Madison County in SW¼ NW¼ Sec. 33, T. 1 S., R. 2 E.

(Special Report 15, page 142)

	Character of Material	Thickness Feet	Depth Feet
Well started in Fort Payne chert			
Top of Silurian			83
Silurian / Ordovician	Limestone with partings of shale	975	1058
Bottom of well reported to be			1077

Of 28 wells in Madison County listed in Special Report 15 only 5 show a depth of more than 1,000 feet, which seems essential to reach the Silurian horizon, and of these the two records given above are the only ones available.

The record of a well about 2 miles southwest of Huntsville (3) shows it to have gone far below the Silurian strata. According to the following data no beds were encountered in the Silurian that could be suspected of being iron ore, although the pink, soft rock may have been slightly ferruginous.

Silurian strata in well (3) Madison County in SE¼ Sec. 3, T. 4 S., R. 1 W.

(Special Report 15, page 145.)

			Thickness Feet	Depth Feet
Well started in Tuscumbia limestone.				
Top of Silurian				170
Silurian	Niagara and Clinton	Dark gray broken lime, drilled easily	98	268
		(Samples 160-240 ft. fine-grained blue limestone.)		
		Pink, soft rock	7	275
Bottom of well in Cambrian or Ordovician limestone				2542

In 1940-41 a well was drilled in Madison County about 1 mile north of New Hope (4). Except for pinkish and red limestone and shale, no ferruginous material was encountered in the well.

Silurian strata in well (4) Madison County 1 mile north of New Hope NE cor. NW¼ NE¼ Sec. 2, T. 6 S., R. 2 E.

		Thickness Feet	Depth Feet
Well probably started in Bangor limestone			
	Character of Material		
	Chattanooga shale	23	497
Top of Silurian about			520
Silurian	Limestone, pink and gray, coarsely crystalline	35	555
	Limestone, dark gray to black, and brownish gray crystalline limestone; black phosphatic material	10	565
	Limestone, gray and greenish gray; with some dark red lime and shale	60	625
	Lime, gray, and gray shale; fragments of dark red shale	5	630
	Limestone, dark gray and greenish gray; brownish gray and black	60	690
	Limestone, green and reddish brown	5	695
	Limestone, green, gray, and dark red	10	705
	Limestone, green, gray, and reddish brown	65	770
Bottom of well in Ordovician limestone			1690

For Madison County 11 wells are recorded by Toulmin,[1] 7 more than were on record when Plate 1 of this report was prepared. Two of these 11 wells are probably already mentioned in this report. In the 9 additional wells red or pink rock was noted in only 2 instances. Most of these wells probably did not reach the Red Mountain formation.

[1]Toulmin, L. D., Op. cit., pp. 95-112.

Jackson County

Jackson County comprises two areas of Carboniferous rocks separated by the Browns Valley anticline, faulted on its northwest margin. In this valley the dolomites and limestones of Cambrian or Ordovician age are exposed. These rocks are not considered promising for oil nor are the "Coal Measures" in the broad syncline of Sand Mountain on the southeast. On the northwest of the valley there may be shallow local folds, and on one of these a well 3180 feet deep was drilled in 1913 in the vicinity of a gas seep in McMahon Cove, about 2¾ miles north of Stevenson (1). Mention has been made of this well in the discussion of the northwest border of Browns Valley, page 310, and it will suffice to state here that very red limestone containing a seam of red iron oxide is reported to have been passed through between depths of 663 and 753 feet. The thickness of the iron oxide seam could not be determined, but it was probably thin and it probably represents the seam of ferruginous siliceous or calcareous rock noted on the outcrop on the southeast side of the valley.

Marshall County

There are two areas of plateau country in Marshall County surfaced with Carboniferous rocks separated by the anticlinal Browns Valley, which is floored with dolomite, chert, and limestone of Cambrian or Ordovician age. The coals give evidence of so high a degree of metamorphism as to discourage prospecting for oil. One record of a well that has been drilled 50 feet into the Silurian rocks does not mention any red beds.[1]

DeKalb County

The principal structures involving rocks that might contain petroleum in DeKalb County are synclinal, and the coals show so much metamorphism that the likelihood of finding oil in commercial quantities has been considered too small to attract capital for prospecting, consequently there has been little or no drilling for oil in this area.

Some drilling has, however, doubtless been done for coal in the Sand Mountain and Lookout Mountain basins and a few of

[1]Toulmin, L. D., Op. cit., pp. 118-120.

these drillings may have been continued down as deep as the red iron ore zone in the Silurian rocks, but no authentic records are available of such work. Certain of these prospectings, it is suspected, were carried on in connection with promotion projects and the detailed records would not stand careful scientific scrutiny and have therefore been withheld, together with the exact location of the prospects.

Etowah County

In Etowah County Coal Measures occur in the southwest end of Lookout Mountain and in the northern part of Blount Mountain. Both of these areas are synclinal and their ocals show such a high degree of metamorphism as to make the possibility of oil in commercial quantities seem negligible. There are no records available of drillings that have reached the Silurian rocks in this County except in Little Wills Valley near Crudup and Keener where the drilling was for information concerning iron ore.

Colbert County

A well drilled for oil in 1940 about 3 miles south-southwest of Margerum (1) passed through red and pink limestone, but showed no other sign of ferruginous beds.

Silurian strata in well (1) Colbert County 3 miles south-southwest of Margerum in S½ of SW¼ of SW¼ of NW¼ of Sec. 10, T. 4 S., R. 15 W.

		Thickness	Depth
		Feet	
Well started in limestone of Chester age			
Top of Silurian about			693
Silurian	Shale, gray	32	725
	Limestone, red	11	736
	Limestone, green, shaly	25	761
	Limestone, pinkish	12	773
	Limestone, red and green shale	12	785
	Limestone, red	13	798
Limestone, dark gray, (top of Ordovician)		220	1018
Bottom of well in Cambrian or Ordovician dolomite			1679

Another well is at Sheffield (2) data of which follow:

Silurian strata in well (2) Colbert County at Sheffield (Special Report 15, page 74)

(Special Report 15, page 74.)

		Thickness	Depth
		Feet	
Well started in Tuscumbia limestone.			
Top of Silurian			496
	Character of Material		
Silurian and	Shale, lime and flint	526	1022
Ordovician	Limestone, hard, capping second sand	38	1060
	Sand, very hard, some oil and gas	32	1092
(Trenton)	Limestone and flint (Bottom)	458	1550

Apparently nothing in the nature of red iron ore was encountered in this drilling.

The other recorded well is about 7 miles southeast of Sheffield near Spring Valley (3) and showed some pink and red colored limestone:

Silurian strata in well (3) Colbert County in sec. 12, T. 5 S., R. 11 W.

(Special Report 15, page 75.)

		Thickness Feet	Depth Feet
Well started in Tuscumbia limestone.			
Top of Silurian			475
Silurian	Green shale	8	483
	Light green lime	12	495
	Pinkish white lime	10	505
	Red soft lime	47	552
Bottom of well in Ordovician limestone			1000

The following log from a well drilled in 1911-12 about 7 miles southeast of Tuscumbia, and 2 miles S. of Spring Valley near the crest of the Carey anticline was recently acquired by the Alabama Geological Survey. The log was not included in the report by Doctor Semmes.

Silurian strata in well (4) Colbert County about 7 miles southeast of Tuscumbia SW¼ sec. 7, T. 5 S., R. 10 W.

Mississippian	Chattanooga shale	428-483
Silurian	Shale, green	483
	Lime, light green	495
	Lime, pinkish white	505
	Lime, red, soft	552
	Lime, gray, soft	595
	Lime, dark green	600
	Slate	675
	Slate	685
	Lime, gray, soft	690
	Slate	705
	Lime, gray	718
	Slate	742
Ordovician	Top of Trenton at	800
	Bottom of well in Ordovician limestone	1577

In addition to the above a well is reported to have been drilled at Littleville in Sec. 27, T. 5 S., R. 11 W., to the depth of 2,900 feet, which in all likelihood passed through the Silurian strata, but no section of this well is given, nor is a section given for a well 1,000 feet deep in the NW¼ of NW¼, sec. 28, T. 3 S., R. 14 W., near Chisca, which may or may not have penetrated the Silurian rocks.

Franklin County

On account of supposedly favorable structure for the accumulation of oil and gas in various parts of Franklin County in the Ordovician as well as the lower Mississippian beds several wells have been drilled through the Silurian rocks. In the northern part of the county at Frankfort (1) a distinctly ferruginous horizon was reported between depths of 917 and 998 feet, but the drillings seem not to have been rich enough to be classed as iron ore.

Silurian strata in well (1) Franklin County in N. E. corner of NW¼ Sec. 7, T. 6 S., R. 12 W.
(Special Report 15, pages 110-111.)

			Thickness	Depth
			Feet	
Well started in Hartselle sandstone.				
Top of Silurian				784
		Character of Material		
Silurian	Niagara (?)	Limestone, slightly sandy, white, (slush looked like stream of clabber)	65	849
		(Note—A little saft water at 790 ft.)		
		Shale, greenish to grayish	68	917
	Clinton (?)	Limestone, sandy, with reddish, highly ferruginous argillaceous inclusions	10	927
		Same, growing more ferruginous	18	945
		Limestone, hematitic, with apparently little or no silica	30	975
		Same with slightly less iron	23	998
Bottom of well in Cambrian or Ordovician dolomite				2005

At Russellville (2) according to a record by Prof. W. O. Crosby in the files of the Geological Survey of Alabama a well started in the Bangor limestone passed through the Silurian ("Clinton" and "Niagaran") rocks but showed no iron ore.

About 5 miles southeast of Russellville (3) a well was drilled which showed red and green calcareous shale and limestone but no iron ore:

Silurian strata in well (3) Franklin County in SW¼ of Sec. 15, T. 7 S., R. 11 W.
(Special Report 15, page 105.)

		Thickness	Depth
		Feet	
Well started in Bangor limestone.			
Top of Silurian			1240
	Character of Material		
Clinton	Shale, calcareous, red and green	140	1380
	Limestone, greenish white	20	1400
Bottom of well in Cambrian or Ordovician dolomite			2560

In the southern part of the county, near Atwood (4) a well was drilled with cable tools to a depth of 1820 feet to the base of an 8-foot bed of red rock where it was continued by a diamond drill to a depth of 2609 feet. It is unfortunate that the red rock was not drilled with the diamond bit so that something definite might be known concerning the resemblance of this red rock to red ore. The section which follows gives the unusual thickness of 615 feet for the beds classed as Silurian but only the upper portion beginning with beds of the red rock may belong to the Red Mountain formation:

Silurian strata in first well drilled in Sec. 26, T. 8 S., R. 14 W. (No. 4, Franklin County)

(Special Report 15, page 107.)

			Thickness	Depth
			Feet	
Well started in rocks of Pottsville formation.				
Top of Silurian				1401
		Character of Material		
Silurian	Niagara	Lime, sandy, very hard	42	1443
		Limestone	75	1518
		Sandstone, light, limy	12	1530
		Limestone, very hard	70	1600
	Clinton	Lime, slaty, soft	8	1608
		Lime, slaty, hard streaks	131	1739
		Slate, soft limy	23	1762
		Limestone, hard	11	1773
		Limestone, hard	1	1773
		Red rock, limy	39	1812
		Red rock, blood red changing to lighter at bottom hole	8	1820
		DIAMOND DRILL CONTINUATION (In the main by W. J. Douglass)		
Silurian	Clinton (?)	Limestone, very white, crystalline	5	1825
		Shales, green and black	16	1841
		Limestone, dark gray, sandy	35	1876
		Shale, dark, limy, contains sand	20	1896
		Limestone, shaly, sandy, pyritiferous or chalcopyritiferous in last 2 ft.	17	1913
		Limestone, shaly, sandy, pyritiferous or chalcopyritiferous in last 2 ft.	14	1927
		Shaly formation, conglomerate in appearance	10	1937
		Limestone and alternate shale	40	1977
		Shale, pyritiferous in places. Last 4 ft. crystalline limestone with indication of oil	39	2016
Bottom of well in Cambrian or Ordovician dolomite				2609

A second well was drilled about 300 feet south of the one shown above and was carried to a depth of 4,000 feet. The Silurian rocks were encountered at about the same depth but were not found in such a great thickness. The red rock comes in at nearly the same depth below the Devonian, 358 feet as compared with 369 feet in the first hole.

Silurian strata in second well drilled in Sec. 26, T. 8 S., R. 14 W. (Near No. 4, Franklin County)
(Special Report 15, page 108.)

			Thickness	Depth
			Feet	
Well started in rocks of Pottsville formation.				
Top of Silurian				1390
		Character of Material		
Silurian	Niagara (?)	White sandy limestone	16	1406
		Hard limestone	194	1600
		Cherty limestone	74	1674
		Shaly limestone	24	1698
		Pure lime	16	1714
		Shaly limestone	31	1745
		Hard limestone	19	1764
	Red Mountain	Red rock	36	1800
		Gray marble	8	1808
Bottom of well in Cambrian or Ordovician limestone				4000

Lawrence County

In Lawrence County four wells are recorded as having passed through the Silurian rocks. Characteristic reddish colors are recorded in the Silurian in these wells and in the last one given below the red material is noted as "closely resembling Clinton red ore":

Silurian strata in well (1) Lawrence County, in NW corner of NW¼, Sec. 24, T. 6 S., R. 9 W.
(Special Report 15, page 134.)

			Thickness	Depth
			Feet	
Well started in Bangor limestone.				
Top of Silurian				817
		Character of Material		
Silurian	Niagara Clinton (?)	Limestone, greenish	30	847
		Limestone, reddish brown, soft and shaly	65	912
		Limestone, gray and greenish with red specks, impure yellow lime, and streaks of greenish shale; blue limestone, streaks of dark blue shales and sand, fossils in lower portion (rainbows at 939-959 ft.)	205	1117
Bottom of well in Ordovician limestone at				1344

Silurian strata in well (2) Lawrence County in SW¼ SE¼ Sec. 11, T. 7 S., R. 7 W.
(Special Report 15, page 135.)

		Thickness	Depth
		Feet	
Well started in Bangor limestone.			
Top of Silurian			824
Silurian (?)	White lime, salt water	10	834
	Blue shaly lime	40	874
	Brown lime, oil showing	50	924
	Gray lime	48	972
	Soft red formation	7	979
Bottom of well in Ordovician limestone at			1500

In a well drilled in 1939 about 4 miles southwest of Oakville (3) ferruginous beds are evidenced in the log only by red and pink limestone and shale.

Silurian strata in well (3) Lawrence County about 3 miles southwest of Oakville NE Cor. Sec. 30, T. 7 S., R. 6 W.

		Thickness	Depth
		Feet	
Well probably started in Bangor limestone			
Top of Silurian about			930
Silurian	Limestone, brownish gray crystalline, with pyrite; fragments of pink-tinged limestone pinkish-tinged crinoid stems	10	940
	Shale, dark red; green shale; gray and pink limestone	5	945
	Limestone, light gray, pink, and yellow-tinged, glauconite noted; dark red shale fragments	10	955
	Same with gray glauconitic limestone	5	960
	Same with dark red limestone fragments	10	970
	Limestone, white and brownish, part with greenish color; part of limestone slightly pinkish	10	980
	Bottom of well in Cambrian or Ordovician limestone		2001

Silurian strata in well (4) Lawrence County in SW¼ of SE¼ of Sec. 29, T. 7 S., R. 6 W.

(Special Report 15, page 131.)

		Thickness	Depth
		Feet	
Top of well in Bangor limestone.			
Top of Silurian			905
	Character of Material		
Silurian	Limestones, shaly	17	922
	Limestones, blue	2	924
	Shales, sandy and of mottled (red and white) color	9	933
Bottom in Ordovician (?) limestone at			2120

Silurian strata in well (5) Lawrence County, Sec. 24, T. 7 S., R. 6 W.

(Special Report 15, page 137.)

		Thickness	Depth
		Feet	
Well started in Gasper formation.			
Top of Silurian			863
Silurian	Light gray, greenish and pink limestone, with red material, closely resembling Clinton red ore; pyrite nodules, probably originating in the Chattanooga shale	31	894
	White limestone and blue shale with a small amount of sand	30	924
	Same, but with blue shale predominating	36	960
Bottom of well in Ordovician limestone at			2001

In Lawrence County a record of one well given by Toulmin[1] as completed in September, 1944, reached a depth of 4500 feet. The only suggestion of ferruginous rock was pink, shelly limestone at 765 feet depth, or about 91 feet below the Chattanooga shale. This well is located about 8 miles northeast of Lawrence County No. 1, Plate 1 of this Report.

Morgan County

Two wells are recorded in Morgan County as having passed through the Silurian rocks. One of these, located about 3 miles southwest of Albany (1) is one of the deepest wells drilled for oil in northern Alabama. The Silurian is noted as containing only lime and sand and has a thickness of only 38 feet. The identification as Silurian has been questioned, but is as definite as could be made, as it lies directly below 22 feet of black shale, which is probably Devonian.

Silurian strata in well (1) Morgan County NW¼ of NW¼ Sec. 6, T. 6 S., R. 4 W.
(Special Report 15, page 164.)

		Thickness	Depth
		Feet	
Well started in Lauderdale (Fort Payne) chert.			
Top of Silurian			372
	Character of Material		
Silurian (?)	Lime	13	385
	Sand	25	410
Bottom of well below Cambrian or Ordovician dolomite			4130

The other well is at the site of old Hartselle (2) on the old grade of the Louisville and Nashville Railroad about 1 mile north of the present depot. In the section as recorded no recognition is given to the Silurian rocks but the following data are given to show the relations of the rocks next below the Devonian:

Silurian (?) strata in well (2) Morgan County 1 mile north of Hartselle
(Special Report 15, page 163.)

		Thickness	Depth
		Feet	
Well started in rocks of Hartselle sandstone.			
Base of Devonian			645
	Character of Material		
Silurian (?)	Limestone, shaly, light gray, carrying the first gas at 652 ft.	16	661
Ordovician(?)	Limestone, blue, light and drab	1027	1688
Bottom of well in Cambrain or Ordovician calcareous sandstone at			1730

In 1932-33 a well was drilled for oil about 11 miles northeast of Cullman (3) approximately on the line between Cullman and Morgan Counties. According to the drill log on file with the Alabama Geological Survey the well passed through about 180 feet of Silurian strata, but no red ore shows were found, and there is a marked scarcity of red material.

	Thickness Feet	Depth Feet
[illegible]		480
[illegible]	[illegible]	508
[illegible]	[illegible]	520
[illegible]	[illegible]	530
[illegible]		

[illegible] completed in July, 1945. [illegible] Plate 1 of this report. It is located [illegible] of the SW¼ SE¼ sec. 1, T. 8 S., [illegible] depth of the well was about 2200 feet, and [illegible] beds below a depth of 750 feet [illegible] beds in the section.[5]

Marion County

[illegible] greater part of Marion County is covered by the Tuscaloosa formation [illegible] the "Coal Measures" rocks except along [illegible] that it has not been a simple matter

[5] Toulmin, Lyman D., Well logs of Alabama, 1940-1945: Geol. Survey of Alabama, Bull. 57, 1947, pp. 109-111, and Map No. 171.

to determine the structure or to locate wells in promising territory. A few wells have been drilled, however, the deepest diamond drilling, it is said, having ben put down in search of iron ore. This hole reached a depth of 2,200 feet. It passed through the "Clinton" rocks and stopped in the "Trenton" limestone. Portions of the core smelled strongly of petroleum but no real shows of oil were found. These indications encouraged the drilling of a second well in the same locality, about 2 miles north of Hamilton (1), the record of the Silurian being as follows:

Silurian strata in well (1) Marion County in Sec. 23, T. 10 S., R. 14 W.
(Special Report 15, page 152.)

		Character of Material	Thickness (Feet)	Depth (Feet)
Well started in Pennsylvanian rocks.				
Top of Silurian				1738
Silurian	Niagara	Limestones, cherty, thin shale seams	124	1862
		Marls and shales, greenish, with some layers of dense gray limestone, with occasional pinkish and purplish inclusions	249	2111
		Shales, calcareous, greenish	12	2123
		Limestone, ferruginous, compact, greenish and pink	37	2160
	Red Mountain	Iron ore, hematite, 2 ft.	2	2162
		Limestone, fine-grained, ferruginous, pink	31	2193
Bottom of well in Ordovician limestone at				2393

The record of the lower Silurian rocks here is more characteristic of true strata typical of the Red Mountain formation than most of the foregoing records, in that ferruginous materials predominate and a definite, 2-foot bed of hematite was noted. No analysis is given of the hematite unfortunately for it would have been of scientific interest, if not of commercial value. The thinness of the ore bed and its considerable depth, 2160 feet, are unfavorable factors.

A well drilled in 1940 about 5 miles south-southwest of Hamilton (2) did not show any beds of iron ore in the Silurian strata, although red shale and red limestone are indicative of ferruginous material.

Silurian strata in well (2) Marion County about 5 miles south-southwest of Hamilton SE¼ SW¼ sec. 28, T. 11 S., R. 14 W.

		Thickness Feet	Depth Feet
Well begun in Tuscaloosa (?) formation			
Top of Silurian			2496
Silurian	Shale, dark red; green calcareous shale, chert	7	2503
	Shale, green and dark red	12	2515
	Lime, light gray, purple, and gray; green shaly lime and chert	21	2536
	Same and dark red shale; pink limestone with glauconite; green limestone; crinoid stems with pink limestone matrix	8	2544
	Limestone, dark red and crystalline; purple shale; green limes and shaly lime; soft green greasy shale; Pink and green-tinged limestone	16	2560
	Limestone, pink and red crystalline, with dark red shale	28	2588
	Lime, gray and yellowish fine sandy	7	2595
Bottom of well in Ordovician limestone			2685

Winston County

The surface rocks of Winston County are mostly Carboniferous, or Pottsville formation, although in the western part there are small areas of sand, clay, and gravel of the Tuscaloosa formation and in a few places in the northern part Mississippian rocks are said to be exposed by stream cuttings. Exposures are therefore sufficiently numerous to enable some structural features to be determined. Several wells have been drilled, the records of three of which are given below:

Silurian strata in well (1) Winston County at Haleyville in Sec. 31, T. 9 S., R. 10 W.

(Special Report 15, page 182.)

	Character of Material	Thickness Feet	Depth Feet
Well started in sandstone of the Pottsville formation.			
Top of Silurian			1760
Niagara	Limestone, greenish white	15	1775
Clinton	Shale and limestone, red and green	260	2035
Bottom of well in Cambrian and Ordovician dolomite			2982

Silurian strata in well (2) Winston County probably near Township line, Sec. 6, T. 10 S., R. 10 W.

(Special Report 15, page 183.)

		Thickness Feet	Depth Feet
Well started in sandstone and shale of the Pottsville formation.			
Top of Silurian			1960
Clinton	Limestone, brownish and greenish	90	2050
	Shale, mixed red and green	50	2100
	Shale, mainly red	110	2210
Bottom of well in Cambrian or Ordovician limestone at			3610

Silurian strata in well (3) Winston County near Double Springs in Sec. 28, T. 10 S., R. 8 W.
(Special Report 15, page 184.)

		Thickness	Depth
		Feet	
Well started in sandstone and shale of the Pottsville formation.			
Top of Silurian			1790
Clinton	Red and green limestone and shale	150	1940
	Shale, limestone and shale	40	1980
	Limestone	170	2150
Bottom of well in Ordovician limestone at			2440

None of these wells shows any definite iron ore, although reddish colors were noticeable in the drillings from the lower part of the Silurian rocks.

One well in Winston County recorded by Toulmin[1] near the location of Hole No. 1 of this report shows red rock at 2218 feet depth which is about 183 feet deeper than the zone carrying red and green shale and limestone in Hole No. 1.

Cullman County

Cullman County is underlain largely by the "Coal Measures" which show abundant evidence of local folding. Moreover, the coals are not indicative of high metamorphism, and it might be expected that there would have been more drilling for oil. A well west of Hanceville (1) passed through Silurian strata but data on them are very meager:

Silurian strata in well (1) Cullman County in Sec. 30, T. 11 S., R. 2 W.
(Special Report 15, page 76.)

	Thickness	Depth
	Feet	
Well started in Pennsylvanian (Pottsville formation).		
Top of Silurian		1670
Silurian	150	1820
Bottom of well in Cambrian or Ordovician rocks		2850

Blount County

Blount County is surfaced with "Coal Measures" rocks except in the anticlinal Browns and Murphrees Valleys. These valleys are cut down to Cambrian or Ordovician dolomite so that

[1]Toulmin, L. D., op. cit. pp. 167-168.

[illegible] gas in these anticlines except where [illegible] In 1909 a well was drilled in Sec. 28, T. 12 S., [illegible] to the depth of 1,930 feet, reaching the upper part [illegible] of oil and gas was encountered [illegible] and a gas show in the [illegible]. No [illegible] oil and gas have been drilled since, but numerous [illegible] have been drilled for coal and [illegible]. Oil shows have been reported from these and the rocks are [illegible] saturated with petroleum.[1] [illegible] of the well whose location is mentioned above is as follows:

[illegible] Sec. 28, T. 12 S., R. 3 W.

From records of Geological Survey of Alabama

		Thickness Feet	Depth Feet
Well started in [illegible] sandstone			
Top of [illegible]			530
	Character of Material		
	[illegible]	[illegible]	548
	[illegible] gas [illegible] oil	21	569
	[illegible]	[illegible]	575
	Limestone	15	590
Silurian	[illegible]	5	695
	[illegible]	5	700
	Limestone	15	715
	[illegible]	[illegible]	725
	[illegible] shale	40	765
	[illegible]	15	780
	Shale and limestone	[illegible]	1505
[illegible]	[illegible] gas in large quantities was [illegible]	425	1930

[illegible] record which shows five horizons of ferruginous rock, [illegible] at depth of [illegible] feet, [illegible] interesting and significant especially in connection with the [illegible] wells in Jefferson County farther southwest on the Browns Valley anticline.

Walker County

The general structure of Walker County is reported to be synclinal but minor structures have been recognized along a south dipping monocline that forms a limb of the Browns Valley anticline. The "Coal Measures" rocks are not considered un-

[1]Semmes, D. R. Oil and gas in Alabama: Geol. Survey of Alabama, Special Report 15, p. 7[illegible], 1929.

favorable for oil and gas and 13 wells are listed as having been drilled.

About 4 miles east of Eldridge a well drilled in 1940 is shown by a drill log of the Geological Survey of Alabama to have passed through about 325 feet of Silurian strata. The well is interesting because oolitic ore is reported from a sample obtained between 2738 and 2745 feet. The section also shows red and pink limestone and shale.

Silurian strata in well (1) Walker County about 4 miles east of Eldridge SW Cor. SW¼ sec. 12, T. 13 S., R. 10 W.

		Thickness	Depth
		Feet	
Well begun in Pottsville formation			
Top of Silurian or Devonian about			2454
Silurian or Devonian (?)	Limestone, greenish gray crystalline and shaly; some glauconite present	15	2469
	Limestone, greenish gray, fossiliferous; shale; some glauconite present	9	2478
Silurian	Limestone, greenish gray, fossiliferous; yellowish green limestone; dark red limestone and shale	12	2490
	Same and dull purple glauconitic shaly lime	30	2520
	Shale, dark green; shaly lime; light gray crystalline limestone; some purple and green shale	58	2578
	Lime, purple, shaly; green shale and limestone; dark red shale; red and pink limestone	28	2606
	Shale, purple and green; fossiliferous limestone	60	2666
	Limestone, red, purple, pink, and light gray; purple and light green shale	31	2697
	Lime and shale, purple and fossiliferous; green and gray limestone; dark red and pink fossiliferous limestone	36	2733
	Shale, purple; fossiliferous limestone	5	2738
	Shale and limestone, purple; oolitic ore[1]	7	2745
	Limestone, purple, shaly; yellow and greenish limestone; red limestone; green and gray shale	10	2755
	Shale and lime, dark red; green and gray shale and limestone..	18	2773
	Limestone and shale, green and light gray; dark gray limestone with phosphatic material	6	2779
Bottom of well in Cambrian or Ordovician limestone			4182

Two wells near Jasper, are correlated by their recorders as having passed through the Silurian strata. Red rock, but no iron ore, is recorded for both wells at this horizon. It seems inconsistent that one of these wells should have been given in the classification of formations a thickness of 272 feet while in the other, only a little more than a mile distant only 105 feet of strata were assigned to the Silurian.

[1]The log for the well near Eldridge reported oolitic ore at 2745'. Cuttings on file contained nothing that could be called ore. Sample was composed mostly of ferruginous shale. No ore was in next sample above or below.

Silurian strata in well (2) Walker County in NW¼ of NW¼ Sec. 22, T. 14 S., R. 7 W.
(Special Report 15, page 174.)

			Thickness Feet	Depth Feet
Well started in Pottsville formation.				
Top of Silurian				2600
		Character of Material		
		Lime, red at top	90	2690
	Clinton	Slate, red	20	2710
Silurian	?	Lime, red	10	2720
(Red Mountain formation)		Lime, black, shells	6	2726
		Slate, red	14	2740
		Lime, black	110	2850
		Break of red slate	22	2872
Bottom of well in Ordovician limestone				3004

Silurian strata in well (3) Walker County in Sec. 28, T. 14 S., R. 7 W.
(Special Report 15, page 176.)

		Thickness Feet	Depth Feet
Top of Silurian			2675
Silurian	Lime, red	105	2780
Bottom of well in Cambrian or Ordovician limestone			4005

In addition to the above records for Walker County Toulmin[1] gives several that show no red rock although one of them (Map No. 108) is at the same locality as No. 1, described above and purports to have the same depth (4182 feet) carries a very different record from that of Well No. 1.

Jefferson County-Walker County Line

Strictly speaking, Jefferson County is part of the Birmingham District, rather than in northern Alabama, but certain drill records are available in the Warrior Coal Field that shed interesting light on the red iron ore at depth here. The general structure of the Warrior field in Jefferson County is synclinal, flanked on the northwest by the southwestward continuation of the axis of the Browns Valley anticline. The percentage of fixed carbon in the coal is high, a condition unfavorable for large accumulations of oil, but it is considered that the possibility for gas in commercial quantities is fair. Exploration for oil has therefore not been very active in Jefferson County, but between 1911 and 1920 several wells were drilled along the axis of the Browns Valley anticline chiefly in exploration for iron ore, although information concerning oil and gas was also desired.

[1]Toulmin, L. D., Op. cit., 136-143 and Map Nos. 106-108 and 128.

The well, a portion of whose section follows, yielded some encouraging shows of gas and one small show of oil. The published record does not show any actual ore in the Silurian but does show ferruginous sandstones. Although this well is given as in Jefferson County its location when platted on the 1:500,000 scale map of Alabama actually falls within Walker County according to the boundary as shown on that map.

Silurian strata in well (1) *near Jefferson-Walker County line in center of Sec. 27, T. 15 S., R. 5 W.*
(Special Report 15, page 117.)

			Thickness	Depth
			Feet	
Well started in sandstone of the Pottsville formation.				
Top of Silurian				1975
		Character of Material		
Silurian	Niagara	Limestone	20	1995
		Limestone, sandy	30	2025
		Limestone, ferruginous	30	2055
	Red Mountain Formation	Sandstone, brown	10	2065
		Limestone	10	2075
		Sandstone, brown, grading into ferruginous sandstone of the Clinton	270	2345
		Shale, reddish	20	2365
		Sandstone, brown	35	2400
Bottom of well in Ordovician limestone				3133 ft., 6 in.

Farther southwest on the Browns Valley anticlinal axis two more deep wells were drilled. One of these, located near Flat Creek, encountered numerous shows of oil and gas. A very careful record is reported to have been kept of this well, which was made by churn drill to a depth of 2263 feet and by 1-1/8-inch core diamond drill below. The record of the Silurian which follows is of interest in showing three horizons of iron ore within 80 feet of the formation. The iron ore, 7 feet 3 inches thick at a depth of 2995 feet, was composed of an excellent grade iron ore except that the phosphorus content, as shown in analyses by David Hancock, is much higher than the average for Birmingham ores. (Page 357.)

Silurian strata in well (2) Jefferson County line (Flat Creek No. 1 Well) in NE¼ of NW¼, Sec. 19, T. 16 S., R. 5 W.

(Special Report 15, pages 118-119.)

			Thickness		Depth	
			Ft.	In.	Ft.	In.
Well started in Pottsville formation (Jagger (?) coal seam.)						
Top of Silurian					2581	
		Character of Material				
Silurian	Red Mountain Formation	Limestone, coarse—crystalline, white to pink colored with green shale and ferruginous partings	126	......	2707	......
		Hard brown sandy shale, green in places	6	......	2713	......
		Pinkish, coarse, crystalline limestone	6	......	2719	......
		Greenish shale, limestone seams	18	......	2737	......
		Brown, hard, limy shale and shaly limestone	30	......	2767	......
		Fine-grained, brown, shaly limestone	8	......	2775	......
		Green shale	15	......	2790	......
		Fine-grained brown, shaly sandstone	8	......	2798	......
		Ferruginous sandstone, lean ore	0	6	2798	6
		Fine-grained brown, shaly sandstone, green shale partings	30	6	2829	......
		Green shale, 2 feet lean ore at top	4	6	2833	6
		Lean ore	0	3	2833	9
		Green shale	1	3	2835	......
		Gray sandstone, fine-grained	1	5	2836	5
		Lean ore	6	8	2843	1
		Sandstone, fine-grained lime streaks	10	11	2854	......
		Sandstone, fine-grained shale partings	16	......	2870	......
		Green shale	6	3	2876	3
		Lean ore, mottled with white lime, fossils	0	3	2876	6
		Green sandy shale	2	0	2878	6
		Lean sandy ore	0	6	2879	......
		Shale	1	3	2880	3
		Lean ore	0	3	2880	6
		Sandstone, fine-grained	16	6	2897	......
		Mottle brown shale interbedded with coarse crystalline limestone in about equal parts	25	......	2922	......
		Iron ore	2	8	2924	8
		Coarse pink crystalline limestone with ore interbedded shaly in places, ore about 50% rock	20	4	2945	......
		Fine-grained shaly sandstone green shale interbedded	50	4	2995	4
		Iron ore, good fine-grained (one piece analyzed ran 43.20% in iron)	7	2	3002	6
		Green shale	0	1	3002	7
		Iron ore	0	1	3002	8
		Shale	0	4	3003	......
Bottom of well in Ordovician limestone					3135	......

Analyses of iron ore bed in well (2) near Jefferson-Walker County line (Flat Creek No. 1 well) in NE¼ NW¼ Sec. 19, T. 16 S., R. 5 W.
(By David Hancock, Birmingham, Ala.)

	Composite sample (Per cent)	Computed averages from foot-by-foot analyses (Per cent)
Iron (Fe)	39.80	39.86
Silica (SiO_2)	3.80	3.72
Alumina (Al_2O_3)	2.65	2.65
Lime (CaO)	16.42	16.24
Magnesia (MgO)	0.86	....
Manganese (Mn)	0.13	....
Phosphorus (P)	3.38	3.36
Sulphur (S)	0.112	....
Moisture (H_2O)	0.38	....

For comparison there are given below analyses of three typical iron ores of the Red Mountain formation from the Big Seam being mined in the Birmingham District about 18 miles in an air line southeast of the deep drill hole, but on the opposite side of the Birmingham Valley anticline.[1] The arrangement of these analyses is by mines from southwest to northeast along Red Mountain. The ore from Mine No. 8 is nearly self-fluxing, while that from No. 6 contains about 3 per cent excess of base (lime) and that from No. 13 about 8 per cent excess of acid (silica). The iron in the bed drilled at Flat Creek is higher than the average for ores mined on Red Mountain, and the silica is remarkably low, so low, in fact, that the relation between lime and silica would indicate a considerable excess of lime. Were it not for the extraordinarily high percentage of phosphorus the ore below Flat Creek would be of a valuable grade.

Analyses of typical iron ores of the Red Mountain formation at Birmingham, Ala.

	Muscoda (Mine No. 6) Per cent	Wenonah (Mine No. 8) Per cent	Ishkooda (Mine No. 13) Per cent
Iron (Fe)	35.92	37.04	36.97
Silica (SiO_2)	11.63	15.16	18.36
Alumina (Al_2O_3)	3.21	3.24	3.01
Lime (CaO)	17.57	14.68	13.01
Manganese (Mn)	0.15	0.17	0.18
Phosphorus (P)	0.30	0.34	0.36
Moisture (H_2O)	1.75	2.03	2.42

[1]Steel-making at Birmingham, Alabama: Tennessee Coal, Iron and Railroad Co., Fourth Edition, 1940, p. 5, 6.

The high percentage of phosphorus (3.36 to 3.38) in the ore below Flat Creek has given rise to speculation as to whether or not it represents the general condition of this ore bed below a large area. It is unfortunate that more specific information as to cores and analysis of the ferruginous material is not available from the other two drill holes near the Jefferson-Walker County line northwest of Birmingham that went deep enough to have penetrated the ore. It would be unwise to condemn the field on the evidence yielded by one drilling, for it is geologically possible that there may have been a local concentration of phosphorus which the Flat Creek well happened to encounter. Small areas of ore carrying as much as 4 per cent of phosphorus are reported to have been found in the Birmingham District but they are avoided in mining the ore.[1] With these conditions in view it would seem essential and perhaps advisable to further carefully explore this area with a diamond drill, preferably following the Browns Valley anticlinal axis toward the northeast, in which direction the Red Mountain formation should lie nearer the surface. The question of depth to the ore bed is also one that must be considered, for a vertical depth of 3,000 feet is greater than has been reached by any iron mining operations in Alabama. Mining engineers state that 3,000 feet is not a prohibitive depth if other conditions are favorable. There would be many advantages in mining a relatively flat ore body and hoisting through a vertical shaft centrally located so that ore might be brought to it from all directions. Besides this, high-grade coking coal is found in the Pennsylvanian strata above the ore and the locality is well served by railroad and water transportation and is close to blast furnaces and steel mills.

The third well was drilled near Praco, with a diamond drill, and the published section of the Silurian rocks follows. It is difficult to understand why, if a core was preserved, the record does not show any definite iron ore beds, as this well is only about 2 miles from the Flat Creek well. However, the top of the Silurian rocks do not correspond closely in depth from place to place and this well shows a thickness of 518 feet of Silurian rocks compared with 422 feet in the Flat Creek hole, so there may have been some inaccuracy in the recording and interpretation of results.

[1]Personal communication from Dr. Stewart J. Floyd, Dean of the School of Chemistry, Metallurgy, and Ceramics, University of Alabama, 1930.

Silurian strata in well (3) near Jefferson-Walker County line near N. E. Corner Sec. 36, T. 16 S., R. 6 W.
(Special Report 15, page 120.)

		Character of Material	Thickness Feet	Depth Feet
Well started in rocks of the Pottsville formation a few feet below Mary Lee coal seam.				
Top of Silurian				2832
Silurian	Niagara	Limestone, massive	14	2846
		Limestone, massive, highly ferruginous	25	2871
	Red Mountain	Shales, ferruginous	20	2891
		Shales, vari-colored, calcareous layers	109	3000
		Shales, ferruginous	5	3005
		Sandstones, shaly, slightly ferruginous in places	145	3150
		Bottom of hole March 1, 1920	200	3350

The results of deep drilling near the Jefferson-Walker County line have by no means proved the existence of a large field containing a bed of ore of workable thickness. The question arises as to what significance there would be in the discovery of large reserves of high-phosphorus ore. In Europe[1] iron ores from Lorraine with a phosphorus content of 0.3 to 0.7 per cent and from Sweden of 1 to 2 per cent, or between that of the Birmingham and the Flat Creek ores are successfully used for making steel by the basic Bessemer process. This process is not employed in the United States and it is uncertain whether or not it would prove successful with these particular ores, but if it or some modification of the process could be used, a valuable byproduct in the form of high phosphorus slag fertilizer could be produced in large quantities.

Suggestions as to future drilling

The question may well be asked also as to whether the results of deep drilling in the other counties in northern Alabama as outlined above have contributed anything definite to knowledge concerning the red iron ore measures below the plateau country. In the opinion of the authors the evidence has been preponderantly negative and discouraging, although perhaps not conclusive. During the preparation of this report the senior author was asked for his opinion as to the advisability of the expenditure of a fund

[1]Roesler, Max, The iron-ore resources of Europe: U. S. Geol. Survey Bull. 706, pp. 62 and 96, 1921.

to be subscribed by the citizens of an enterprising industrial community in order to demonstrate the extent and quality of neighboring deposits of coal and iron ore. To this inquiry the following reply was made:

"You ask a very practical question, whether I would recommend that the citizens put up a fund of $50,000 to demonstrate the extent and quality of the coal and iron deposits within a radius of 30 miles of your city. My report will give most of the available facts concerning the outcrops of the iron ore beds. I have made no study of the coals. My studies of the ore outcrops might be supplemented by some prospecting, but that would be slow and tedious work and probably would not yield much more information than is at present available because the ore beds do not change much within the short distances that could be penetrated by digging prospect trenches or drifts. * * * * * *

"The only kind of prospecting that will yield the kind of information that is most needed would cost to do it thoroughly several times $50,000. This prospecting would be a campaign of deep drilling in the areas of Pennsylvanian rocks ("Coal Measures") of Lookout, Sand, and Blount Mountains, and such drillings should be carried down through the horizon of the red iron ore. Cores should be taken of the coal and iron ore beds if these materials are found. Several shallower holes should be drilled near the margins of these fields, as, for instance, in the back valleys between Lookout Mountain and Shinbone Ridge on one side and Red Mountain on the other, also along the southeast foot of Sand Mountain and in Greasy Cove. All this drilling should be located, supervised, and checked by a competent engineer-geologist interested primarily in getting at the facts as efficiently and expeditiously as possible. I have for years hoped to see some systematic deep drilling in the areas mentioned and think it would be desirable if the community could carry out such a plan, but, if not, then any local interest which desired to defray the cost of such a campaign for its own benefit should be encouraged to carry it on. Such a plan would involve an element of risk of not finding satisfactory deposits; plenty of delay and trouble would be encountered and the cost would be much more than you have suggested, but it is the only kind of investigation that I would recommend."

SUMMARY OF IRON ORE RESERVES IN RED MOUNTAIN FORMATION IN NORTHEAST ALABAMA

The question of reserves of bedded iron ore in northeast Alabama may seem to be of little practical interest at present. Estimates of the tonnage of these ores in the Birmingham, Alabama, and Chattanooga, Tennessee, districts, published in 1908 and 1909 respectively, are of interest now chiefly for purposes of comparison. Those for the Birmingham District were conservative and since they were made much more ore has been discovered by deep drilling. For the northeast Alabama part of the Chattanooga district also the totals were conservative, although emphasis was not everywhere well distributed. This is the area with which the present report is concerned. Conditions have changed here in so many respects that it is with reluctance that present consideration is given to the problem of ore reserves.

Among the factors involved are changes in mining and metallurgical practice, changes in markets affecting the demand for and the value of the ore, costs of labor and supplies, advances in knowledge of the deposits as revealed by new exploration, records of past production, and conditions affecting underground mining, quality of the ore, its thickness, attitude, and structure of the ore beds, relation to topography and water level, and continuation of ore in depth. Marketing conditions have changed greatly, for since 1909 blast furnaces at Chattanooga, Tenn., Rising Fawn, Ga., and at Battelle, Ala., all of which were purchasers of this local ore have been dismantled and only two furnaces are at Gadsden in blast in 1946.

With regard to the minimum workable thickness, the poorest acceptable quality, and the other limitations that may be imposed by the various factors mentioned above, it may be said that all are more or less interdependent. For instance, a very rich ore can be worked in thinner and more disturbed beds than a lean ore. A rich and thick ore bed whose extent is known to be limited by a fault may not warrant the outlay necessary for a railway spur and the necessary mining equipment, which might be warranted by a thinner and leaner bed whose extent has been proved by prospecting to be much greater. Iron ore beds near Ooltewah, Tenn., have been worked in a small way for paint material, but in general there has been no extensive underground mining of

beds whose thickness averaged less than 2 feet, nor does self-fluxing ore carrying less than an average of 25 per cent of metallic iron seem to be considered minable. In fact, no one acquainted with iron making in the South would at present be interested in mining a 2-foot bed of ore averaging 25 per cent of metallic iron, no matter how extensive or easily accessible it might be. With changing conditions, however, such an ore bed may become of considerable value at some future time, and for this reason it was thought best to include the outcrop of such beds in the present report.

The maximum distance down the dip measured from the outcrop or the maximum vertical depth below the level of the outcrop to which an ore bed may profitably be worked are greatly affected by other factors. As early as 1908 in some slopes where the ore was thin or of poor quality the limit of workability had been reached and mining had been discontinued. Other slopes that were driven on fairly thick ore of good quality had penetrated to far greater distances than the abandoned slopes and were operated at a profit for many more years. Obviously no workable limit can be applied to ore in such localities. In 1908, a vertical depth of 1,000 feet was taken as an arbitrary limit to which the bedded iron ore in the eastern states might be considered available under conditions prevailing at that time. No active slope had reached more than half that vertical depth and some had been abandoned at much less depths. Although nearly 40 years have elapsed since those estimates were made, one would now hesitate to place a limit of workable ore at 2500 feet, vertically below the surface, provided the quality and thickness of the ore were satisfactory. It is therefore evident that the limit of workable ore in depth is a progressing factor, and one which can not be assumed with any degree of certainty in making estimates of ore reserves.

It is an important question as to how well surface conditions can be depended on to indicate the thickness, quality, continuity, and structure of an ore bed beneath the surface. Surface indications in regard to the quality of an ore bed, provided it has been prospected back to the hard ore, are fairly reliable. If prospect pits extending a sufficient distance along the outcrop have disclosed hard ore of uniformly good quality it may reasonably be assumed that the bed may continue below the surface with but little deterioration. A few exceptions to this rule have, however,

been noted. The variations in quality and thickness along the outcrop should be carefully noted. Variations are characteristically more abrupt in the direction of the dip than along the strike of the ore beds. The structure of the beds overlying the ore should be noted carefully, as there naturally exists a certain parallelism in structure between surface and underlying beds. Faults or dislocations in the strata should be carefully located and it should at once be determined whether the beds beyond the fault have moved relatively up or down, or laterally. If they have moved upward, was the upthrow sufficient to bring the ore bed above the surface and thereby terminate its extent in that immediate vicinity? If the rocks beyond the fault were dropped, instead, to what depth is the ore depressed? To what depth has the ore dipped below a given point on the surface? These questions can perhaps be answered by careful geologic study, but it may require deep drilling to confirm such points definitely. For instance, at a certain mining operation in Alabama, if the geologic evidence had been given due weight, much expense and futile search for ore might have been avoided. At the outcrop the ore dipped at a moderate angle and conditions were evidently favorable for the driving of a slope, but at a few hundred feet in the direction of the dip, an abrupt change occurred in the surface rocks. A highly fossiliferous chert adjoined an area of non-fossiliferous chert and dolomite. The fossiliferous beds were those of the Fort Payne chert, which normally lies 150 to 200 feet above the iron ore; the non-fossiliferous beds were of Cambrian age which normally lie many hundred feet below the ore. No attention was paid to these geologic conditions, but a slope was opened and elaborate preparations were made for mining. Within a few hundred feet the slope ran into broken ground and the ore was lost. Two other slopes were driven, both of which encountered the same difficulties. The evidences of a fault, which had carried the ore-bearing rocks above the present surface were plain enough, but instead of heeding them the owners drilled a hole nearly 1,000 feet deep in search of ore in the dolomite. Thorough deep drilling—in the **right** place—is most strongly advocated. Too little drilling has thus far been done in the ore fields, probably because of the great expense, but the expense is generally well justified, by the information obtained concerning depth to ore, thickness and quality of ore, dip of the beds, etc., provided a preliminary geologic study is made so that the drill hole is judiciously located.

The great extent to which the soft-ore beds were formerly worked at the surface is one of the factors that has led to the worst misapprehension concerning southern iron ores in general. To persons who are engaged in pursuits wholly unrelated to mining, but who may be interested in mineral lands from whose surface there was produced 20 to 50 years ago a considerable tonnage of rich soft ore, it naturally appears reasonable to believe that this mining activity should at some future time be revived. It should be necessary only to recall two points in this connection. First, surface mining is the cheapest method of working the ore beds. It requires comparatively little outlay for equipment, and it can be terminated and the outfit moved away without great loss when the work becomes unprofitable. Second, the soft ore, which was obtainable at the surface, was much richer in metallic iron than the hard ore which is to be expected below the ground-water level. If these two points are borne in mind, it will readily be seen that to be workable underground an ore bed must have a thickness much greater than the 6 to 18 inch seams that were once stripped and trenched for many miles along their outcrop in the southern Appalachian area.

In the Chattanooga report, published in 1909, the estimates were made on ore considered as then available and on ore believed not to be available at that time. If the present report only one classification is made, irrespective of whether the availability is for the present or the future. In fact, unless economic conditions change for the better it is hardly to be expected that much of the present ore will become available for mining except under emergency conditions more critical than those of World War II, or else not until the more abundant ores in other parts of Alabama are more nearly exhausted. In 1909 the ore along the borders of the Lookout Mountain syncline in northeast Alabama considered as available only for future use amounted to about 312,000,000 long tons. (Shinbone Ridge, 31,821,000 long tons and Wills Valley, 28[illegible],000,000 long tons) This block of ore measured 3,000 feet on the dip on 52,000 feet (9.83 miles) of Shinbone Ridge outcrop and 10,000 feet down the dip on 132,500 feet (25 miles) of outcrop between Attalla and Battelle. The thickness of the ore was figured at 3¼ and 3 feet respectively. It would be reasonable to consider this as potential ore available for the remote future if there were satisfactory data as to the conditions beneath the surface of the Lookout Mountain syncline. Theoretically, the beds of

iron ore in the Red Mountain formation should extend without major interruptions from the west border of Lookout Mountain below the Carboniferous rocks and emerge on the east limb of the syncline. It very likely does this as is indicated by the outcrops on Red Mountain on the west side and on Shinbone Ridge and Pigeon Mountain on the east side of the syncline. The distance across the syncline between the red ore outcrops is only 4 to 10 miles and it is likely that below the axis of the fold the rocks lay comparatively flat and have sustained less faulting and other structural deformations than along the outcrops. There may be changes in the character of the ore between the outcrop and the axis of the syncline. Beds, which on the outcrop, appear to vary in thickness and quality may do likewise in the direction of the dip, and in that direction the changes may be more abrupt than along the outcrop. Such conditions are found in the Birmingham district. Several mines in the Birmingham district extend for more than 10,000 feet in the direction of the dip, but they are mining hard ore 2 to 4 times as thick as 3 feet, and it probably carries several percent more metallic iron than the average of the Wills Valley hard ore. The Shinbone Ridge area offers possibly a slightly better grade of ore than Wills Valley. Shinbone Ridge near and northeast of Gadsden has been much disturbed by folding and faulting and ore has not been found by drilling in Owl Valley to continue below the surface toward Lookout Mountain. More drilling is needed here in order to solve a serious structural problem and open the way to exploration of a potential supply of conveniently located iron ore.

Evidently very much depends upon further exploration by drilling, either under Governmental or private sponsorship. While such projects necessarily would be speculative, their success would mean much for public and industrial welfare.

The rocks of the Red Mountain formation on the east side of the Lookout Mountain syncline have not been correlated perfectly with those on the west side, although it is believed that beds of iron ore of Brassfield age are present at the Citico mine on Shinbone Ridge and in Greasy Cove. It is fair to expect, however, that the Red Mountain formation in Lookout Mountain may contain overlapping lenses of iron ore of varying character. The vertical depth at which the iron ore lies below the surface of the greater part of Lookout Mountain is estimated to range between

1,500 and 3,300 feet. This estimate is derived from 10 carefully measured sections on the borders of Lookout Mountain made by geologists of the United States Geological Survey in 1890. No drill holes have been driven to such depths on Lookout Mountain. One recent drilling for coal east of Fort Payne is reported to have a depth of 1040 feet. This drill passed through 557 feet of the Pottsville formation and 483 feet of the Pennington formation without reaching the base of the latter. Three very thin seams of coal were cut in the Pottsville formation. Many other holes were drilled, the deepest of which was 552 feet, and their average depth was about 145 feet. This drilling campaign might have afforded a good opportunity to explore deeper for iron ore beds, but, unfortunately, the drilling machine was not capable of penetrating to a much greater depth. Moreover, coal was the sole object of the search.

The method of estimating the iron ore tonnages in the areas of northeast Alabama other than Greasy Cove has followed the plan used for that area, but in less detail. For Greasy Cove a definite quantity of ore estimated as past production has been deducted in the table for that area, page 103, and as the assumed widths on the dip average less than in the other areas, only 10 percent has been deducted for loss in mining. This may have been too little. From the totals of the other areas 15 percent has been deducted for loss in mining and in all the tables the quantities are expressed as net after mining. Difficulty has been experienced in obtaining figures on past production of ore, consequently only a rough estimate was attempted. This quantity has been deducted in a lump sum from the total estimated reserves of the whole area.

Such estimates as it has been feasible to prepare are significant only as they may indicate the ore that might be present under the given conditions and provided that the ore beds at depth have not deteriorated materially as compared with the ore as known on the outcrop and underground. The estimates may be serviceable for comparison with figures on other districts and as a basis for approach to the problem of exploring the Lookout Mountain syncline, which seems to be the only large iron ore-bearing area remaining to be thoroughly tested in Alabama.

The following table summarizes the estimates of tonnage of bedded iron ore in northeast Alabama and the data on which these estimates are based. The quantities recorded in the table should not be confused with those cited from the Chattanooga report published in 1909. They comprise a part of the earlier estimated reserves but do not extend as far down the dip nor below Lookout Mountain. The table shows that the southeast side of Wills Valley, credited with about 31 million long tons of ore, leads the list, followed by the Springville area, Shinbone Ridge, Greasy Cove, the northwest side of Wills Valley, and Murphrees Valley. The reserves of these units range from 8½ million tons down to 1-7/10 million tons. Less than 1 million tons are estimated for Greens Creek-Colvin Mountain and the 52,000 tons estimated for Round Mountain, is perhaps, beyond recovery. The grand total of about 51 million tons of indicated and inferred recoverable ore does not, of course, rank high as an ore reserve today, but it would be very welcome locally if it could be converted into pig iron within the next generation. Wherefore, the recommendation for more drilling, particularly along the southeast side of Wills Valley and on Shinbone Ridge, near Gadsden, still stands.

Since the above computations were made interest has arisen in the question of "potential" iron ore. Large quantities of ore of this class may be inferred to extend from the bordering outcrops to beneath the Lookout Mountain plateau. Assuming an average thickness of only 3 feet for the ore bed, an area of 341 square miles, and 12 cubic feet to 1 ton, a total of 2,376,634,000 long tons is estimated fos the area within Alabama.

Core drilling in progress early in 1947 by the U. S. Department of the Interior Bureau of Mines in Owl Valley southeast of Lookout Mountain is understood to have shown a thickness of more than 3 feet of red iron ore. The Bureau of Mines will issue a report on this drilling upon the completion of the project.

Drilling on the Lookout Mountain plateau will, of course, be essential in order to demonstrate whether or not the ore bed actually is present throughout the syncline.

Summary of data on iron ore beds 2 or more feet thick in northeast Alabama

Locality	Dips (d), and structural features (s)	Approximate length outcrop on strike (L) Miles	Feet	Estimated average width on dip Feet (D)	Apparent average thickness Feet (T)	Estimated cubic feet per long ton (N)	Estimated quantity recoverable, soft semihard, and hard ore (Long Tons)
1. Greasy Cove (Plate 2) (Details on page ......)	(d) Moderate to steep and and overturned (s) Faulted and folded in places	6.45	34,056	600 to 1,200	2.25 to 4.	11 to 12	7,506,600
2. Wills Valley, SE side (Plates 3, 4, 5, 6, 7, 8)	(d) Moderate to steep (s) A few folds and small faults.	27.6	145,728	1,000	3	12	30,970,000
3. Wills Valley, NW side (Plates 3, 5, 6, 7, 8) Includes Sulphur Springs and Pudding Ridge	(d) Steep to moderate; (s) Many folds and faults	7 7	40,656	300	2.9	12	2,505,000
4. Shinbone Ridge (Plates 3, 4, 9, 10)	(d) Steep to moderate; (s) Folded, faulted and overturned beds.	8	42,240	1,000	2.6	13	7,779,000
5. Round Mountain (Plate 9)	(d) Steep to moderate; (s) Small faults and fractures	0.35	1,848	200	2	12	52,000
6. Murphrees Valley (Plate 11)	(d) Moderate (s) Fault cuts out ore bed near Aurora	1.75	9,240	1,000	2.6	12	1,702,000
7. Springville to Whitney (Plate 12)	(d) Moderate to steep and overturned.	8	42,240	1,000	2.85	12	8,527,000
8. Greens Creek-Colvin Mtn. (Plate 14)	(d) Moderate (s) Faults	1	5,280	400	2.9	12	813,000
Approximate total outcrops of ore beds 2 feet or more in thickness		60.85	321,288				
Approximate total recoverable soft, semihard, and hard ore in beds 2 feet or more thick to indicated distances down the dip, before mining:							59,854,000
Less estimated past production, all areas:							9,031,000
Estimated net reserve indicated and inferred recoverable ore, Long Tons:							50,823,000

INDEX

This index does not aim to include topics that are mentioned very frequently, such as iron ore, Red Mountain formation, hard ore, soft ore, fossiliferous ore, hematite, limonite, anticlines, synclines, faults, folds, limestone, sandstone, mining, etc.; or unimportant items that no one would be likely to look for; though "border-line" cases have been given the benefit of the doubt. Localities are covered pretty well by the table of contents, but many are indexed also, especially if they are mentioned on several different pages, for the benefit of persons who may be interested in some particular one. Numbers in parentheses refer to pages where a given topic is mentioned indirectly.

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